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ABSTRACT

This guide for elementary teachers provides information on getting ideas into action, designing and implementing the right situation, ways in which to evaluate science process activities with students, and seven sample units. The units cover using the senses, magnets, forces, weather forecasting, classification of living things, and the physical characteristics of water. An appendix provides a variety of books, film sources, supply houses, and other references of value in enriching the science program. (SA)

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ELEMENTARY SCIENCE
Resource Guide

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FOREWORD

This publication is a revision of the *Elementary Science Resource Guide*, Bulletin 695. The publication is not a substitute for a course of study but a guide for developing a local science curriculum for the elementary grades.

The committee of public school elementary teachers and science educators assigned to develop the Guide was directed to design a framework for a laboratory approach to teaching elementary science. The object is not to make all students scientists but to enable them to take their places as citizens in the modern world and to make their adult life more interesting and enjoyable.

It is hoped that this Guide will encourage the development of a program involving the student in individual and group laboratory activities in the elementary school.

M. L. Brockette
Commissioner of Education

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[redacted]

Before answering this question,

STOP . . .

Write in the spaces below the sounds you can hear at this moment.

____

____

____

NEXT . . .

Select three objects near you. What colors are they?

____

____

What are their shapes?

____

____

Describe their positions from where you are.

____

____

____

NOW . . .

Feel the chair in which you are now seated in at least three different places.

List three words that describe what you feel.

____

____

____

THEN . . .

Close your eyes and "sniff" the air around you.

List the words which describe the odors you smell.

____

____

____

FINALLY . . .

Touch the back of your hand to the tip of your tongue.

What does your hand taste like?

____

____

____

By answering these questions, you have been participating in one of the basic processes of science — OBSERVATION. This publication is designed to help you expand your idea of what science is all about and to assist you in learning how to become a more effective teacher.

WHAT IS SCIENCE?

- science is the study of the problems that arise wherever children live
- science is a study of natural environment
- science is asking questions and seeking answers
- science is actively investigating and arriving at conclusions
- science is exercising the processes of discovery and recognizing the products that are derived from these processes
- science is the process by which people try to understand, to control, and to alter their environment
- science is the term applied to a pattern of inductive logic that enables a person to make certain predictions from a collection of tested data

By any definition, science appeals to children's natural desire to investigate and to learn about their environments.

When students are introduced to science, they should be helped to see that science doesn't just mean the content of astronomy, biology, chemistry, physics, etc. More important, science also implies action. Doing scientific procedures involves mental as well as physical activity. A careful examination of branches of science reveals that these activities include the following processes:

- observing
- classifying
- measuring
- communicating
- inferring
- recognizing space-time relations
- recognizing number relations
- predicting
- defining operationally
- controlling variables
- interpreting data
- formulating hypotheses
- experimenting

Although there is no one adequate definition of science, students who participate in the above activities are directly involved, both mentally and physically, in the scientific enterprise.

WHY TEACH SCIENCE IN THE ELEMENTARY GRADES?

Children begin manipulating and sampling parts of their environment before beginning formal school work. The study of science helps them to understand this environment and gives them an appreciation for it. It helps them to have a keener awareness and a greater enjoyment of their environment and to become more curious about it.

Curiosity and answer-seeking are important in the study of science. Answer-seeking is best done through the development of certain skills which are needed to learn scientific facts and principles and to understand the environment. These skills will be useful for keeping up with changing scientific facts and for satisfying curiosity about the environment. They will help prepare boys and girls to live in the world of tomorrow and to enjoy the results of scientific knowledge.

The study of science provides opportunities for critical thinking which enhances the study of other content areas, specifically the social studies, language arts, reading, and art. Social studies makes frequent use of the facts and principles of science. When students are led to gain information for themselves, and to apply this information to situations pertinent to themselves and those around them, they are employing a basic objective of social studies. Science, with its precise vocabulary, contributes to the learning of language arts. By the use of color, shapes, curves, and angles in science, art takes on more meaning. Science can provide the stimulating reasons for reading and communicating. Reading is more effective if the child is stimulated to read as the result of the concrete experiences of science study. By adopting the ways of a scientist, she or he learns to read more critically.

Only a very few children will become professional scientists; however, natural curiosity and the need for understanding, appreciation, and enjoyment of their environment, is evident in all children.

Therefore, science education is not reserved for the future scientist but is provided for all and is needed by all. We have in our classrooms all of tomorrow's citizens. Science is not only a way of thought and action to be used by scientists; it is a method of thought and action essential to all. Everyone needs skill in the use of scientific processes as a way of thinking and reasoning in all situations.

Today's students must adapt themselves to a world that is changing from a natural to a constructed environment. Our world is more than rocks and soil, mountains and valleys, oceans and rivers. We have become an industrial society with technical apparatus, a new vocabulary, and a whole new concept of reality.

Many scientific principles and concepts, if not learned in the elementary grades, may never be known at all. It would be impossible to teach all scientific facts, which constantly change to reflect new knowledge. However, ways of finding answers to problems when based on scientific principles and procedures, will remain the same. They will be useful to students throughout their lives, for satisfying their curiosity about their environment and for preparing them to live in a world build on scientific knowledge.

WHAT DOES SCIENCE DO FOR STUDENTS?

Science is best taught by a series of processes that includes observing, inferring, predicting, using numbers, measuring, using space-time relations, communicating, and classifying. These are the same processes used by scientists.

Through observation, a prerequisite to understanding our environment involving all five senses, a student learns many things. All students have had much experience in observing by the time they begin formal schooling. Careful direction through guided activities, questions, and experiences will increase sensory perception, causing it to become so acute that students will gradually make careful independent observations.

Observation, the first step to understanding environment, leads students to make some mental or verbal inferences. Students can learn to distinguish between facts based on observations they know are true and statements they believe to be true because of certain circumstances. They understand that inferences are most likely to be valid when those inferences are based on statements supported by the most clues. They learn to test an inference for validity. Observation may lead to a prediction that may lead to the stating of a hypothesis that then can be tested. Students can learn to record data accurately, using scientific communication in their records. In this way, students discover the validity of their predictions or hypotheses.

Students can be guided in ways of communication, both verbal and written, through terms that can be understood by everyone. Just as scientific data are of no value unless communicated, experiences of students using scientific procedures are of no value unless communicated in such a way that others can replicate the same experience or work the same experiment. Thus, students learn the importance of accurate reporting. Scientific vocabulary and valid ways of recording data enable students to communicate, whether on a simple or sophisticated level, in terms other people can understand.

Young children realize that certain elements in our environment have similarities and differences and that some can be grouped together. Thus, guidance in classification provides an extension and refinement of what pupils have learned before they start to school. It helps them realize the need for and the purpose of classifying in many of the scientific systems. Children can be led to discover many ways of classifying things, all of which have some validity. Some, however, are more useful than others for a certain purpose. Classifications in certain scientific systems help students see the orderliness of our environment.

Experience with several ways of measuring the components of our environment also helps students realize the orderliness of it. They find that measurements are always the same under identical conditions; however, the purposeful changing of variables will cause different results, some of which may lead to previously unknown scientific facts. A student learns when to estimate quantities and when measurement must be accurate. He or she can be taught to choose a suitable unit for measuring, to become aware of the diverse methods. Measurement, the tool of science, gives a student precise ideas of quantity.

Students become aware of and have an appreciation for space and time through simple experiences, then through gradual guidance into more complex activities as their maturity allows. Those who learn early to observe shapes, curves, and angles as related to space, direction, and time, along with their proper descriptive terms, will have a useful background for a better understanding of science later. They will be able to visualize these things when discussed but not seen and will have an understanding of graphic models for certain scientific systems. They may be able to conceive some models of their own.

Students who are guided in developing the many concepts of numbers needed for and related to the various scientific systems will understand how numbers fit in their environment, a knowledge that will help with other school work. Mathematics may be called the language of science.

Students with experience in collecting and interpreting data can determine if there is sufficient information for the solution of a problem, which data are relevant, and which may be discarded. Here acute and accurate observation (complete sensory perception) is required in order to perceive the unusual in the usual.

GETTING IDEAS INTO ACTION

Certain tasks can be provided within the understanding of students which are designed to help them learn related scientific procedures enroute to understanding scientific concepts. These experiences are guided by the teacher through his or her presentation of a problem, questioning, and selection of activities. As all students manipulate components of their environment, they discover truths and develop a sense of accomplishment at the end of each activity.

To deny any student the opportunity for the study of science is to deny him or her a many-pronged tool for delving into life itself. A role of the elementary school is to preserve the open mind. Effective science teaching is an excellent preservative.

WHEN DO STUDENTS LEARN?

Learning takes place best when all of the senses are involved. Sensory discriminations lead to the stimulation of curiosity which motivates additional learning through discovery. Questions, when properly formulated, direct the learner to precise and accurate observations. These observations, in turn, cause students to reflect, evaluate, and feed back reinforcements or alterations into learning processes. Learning, a result of the foregoing, leads to the formulation of hypotheses which can be tested and modified as variables are applied and observed in the testing processes. Thus, the use of the senses as a beginning point in learning paves the way to extensive knowledge and understanding in the young learner. Initially, then, observation, stressed so greatly in the new approaches to science, becomes the catalyst for new learnings and a tool employed in testing existing hypotheses.

GUIDELINES TO LEARNING

Since the job of the teacher is essentially that of beginning where students are and guiding their learning to a point fixed by limits of capacity, a theory of instruction or a "road map" of learning is needed to help the teacher chart the course for students. Bruner[1] points out that a theory of instruction has four major features:

- the experiences which most effectively implant in the individual a predisposition toward learning
- the ways in which a body of knowledge should be structured so that it can be most readily grasped by the student
- the most effective sequences in which to present the material to be learned
- the nature and pacing of rewards and punishments in the process of learning and teaching

In discussing the fourth feature of a theory of instruction Bruner points out that as learning progresses, there "is a point at which it is better to shift away from extrinsic rewards, such as teacher's praise, toward the intrinsic rewards inherent in solving a complex problem for oneself. So, too, there is a point at which immediate reward for performance should be replaced by deferred reward."[2]

RESOURCES FOR LEARNING

Learning involves more than the assimilation of content in a textbook or any other single resource. It is the total involvement of the student in the act of learning, building on the natural tendencies which he or she possesses for the acquisition of knowledge and skills. One of the most impressive characteristics of human beings is that they learn. Learning tends to be more effective and permanent when based on intrinsic motives. Curiosity, for example, is almost a prototype of an intrinsic motive which leads to learning. The attention of the learner is attracted to something which is unclear.

---

[1] Bruner, Jerome S., *Toward A Theory of Instruction,* Harvard University Press, 1966, pp. 40-41.
[2] *Ibid.*, pp. 41-42.

Another intrinsic motive for learning is the drive to achieve competence. When students are exposed to situations in which they are encouraged to participate, to explore, to test, and to compare, they exhibit eagerness and ethusiasm for learning. The teacher, as a guide to learning, imparts attitudes toward the subject and toward learning itself through the way he or she operates with students.

WHERE DO YOU START?

Let us examine the "road map of learning" in some detail to explore what learning and instruction include. If learning involves the acquisition of knowledge and skills, it reaches its zenith when it is viewed as modification of behavior. What this implies is, that which takes place within the learner is the important aspect of the learning act. This product can only be realized if the learner is directly involved in the processes of learning and if the act is designed to provide for the learner's needs, capabilities, and interests. In reading the Road Map of Learning Figure I, one notes that teaching/learning begins with needs, past experiences, and capacities of students to learn. Needs can be sharpened and directed, past experiences can be modified through compensatory ones, but there is little one can do about capacity to learn other than to provide the best environment possible for cultivation of the potential of the individual learner.

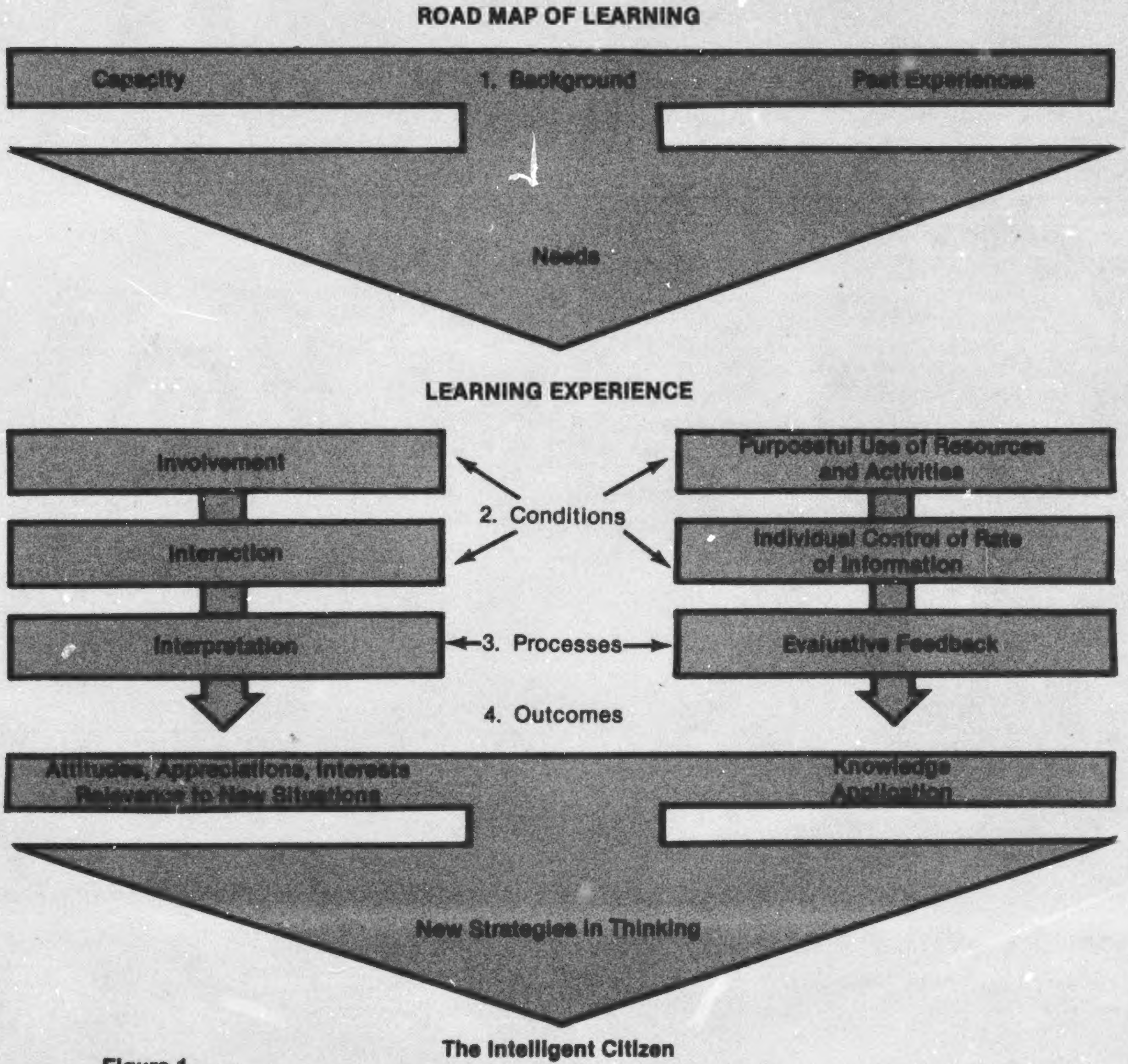

ROAD MAP OF LEARNING
Capacity
1. Background
Past Experiences
Needs
LEARNING EXPERIENCE
Involvement
Interaction
Interpretation
2. Conditions
Purposeful Use of Resources and Activities
Individual Control of Rate of Information
Evaluative Feedback
3. Processes
4. Outcomes
Attitudes, Appreciations, Interests Relevance to New Situations
Knowledge Application
New Strategies in Thinking
The Intelligent Citizen

Figure 1

WHAT CONDITIONS AFFECT LEARNING?

The conditions to be provided that will affect learning and the learning process, should grow out of the needs of the students. If students' needs are considered, their capacities examined, and their past experiences explored, the framework for learning then can be established. Involvement in the act of learning is an important next step along with having opportunities for interaction with others, including the teacher. An abundance of resources that provides for purposeful use and self-selection as to rate of intake sets the conditions for learning. Since students learn from one another, as well as from the teacher, books, and other resources, creating the atmosphere for learning is an important step.

> The corpus of learning, using the word now as synonymous with knowledge, is reciprocal.... Knowledge in this sense is like a rope, each strand of which extends no more than a few inches along its length, all being intertwined to give a solidity to the whole.... What can most certainly be encouraged and what is now being developed in the better...schools is something approximating the give and take of a seminar in which discussion is the vehicle of instruction.[3]

WHAT DOES THE STUDENT DO?

The processes of learning cannot be separated from the conditions which delimit, encourage, or shape it. Interpretation and evaluative feedback are integral parts of the processes of learning. Learners must be able to interpret their learning worlds in their own terms. They in turn modify their learning as they participate in testing and evaluative techniques.

> There is joy in the search for knowledge; there is excitement in seeing, however limited, into the workings of the physical and biological world; there is intellectual power to be gained in learning the scientist's approach to the solution of human problems.
>
> The first task and central purpose of science education is to awaken in the child, whether or not he will become a professional scientist, a sense of the joy, the excitement, and the intellectual power of science.
>
> Education in science, like education in letters and the arts, will enlarge the child's appreciation of his world; it will also lead him to a better understanding of the range and limits of man's control over nature.[4]

HOW DOES LEARNING CHANGE STUDENTS?

Processes lead to *outcomes*. The public generally seems to assume that if evidence of knowledge is present, the outcomes are good. This is, of course, partially true. Knowledge without behavioral changes which allow for the constructive use of knowledge is not only useless but often dangerous and harmful to others. Every teacher desires that her or his students grow in knowledge and in the sophistication which knowledge brings with it. But every teacher also hopes that along with knowledge will come the development of attitudes, appreciations, and interests which will guide the use of knowledge into useful and productive channels. One of knowledge's principal byproducts should be the development of intrinsic motivation for more and more learning. The skills which are involved in the acquisition of knowledge are as important as, if not more important than, the knowledge produced. This is what the Road Map refers to as "application" and "new strategies for thinking." Relevance to new situations is also a part of this phase of development. The youngster whose school experience is really helpful will not only possess great quantities of knowledge but, what is even more important, he or she will acquire the will and skill to apply the knowledge in useful and productive situations.

---

[3] *Ibid.*, p. 126.

[4] Commission on Science, American Association for the Advancement of Science, *Science—A Process Approach: Commentary for Teachers* (Washington: The Association, 1965), p.1.

The outcomes of the learning process are intertwined with new thinking strategies which enable one to act as an *intelligent citizen*. This requires that one make both wise choices and worthy decisions. For many decades, an objective of education has been the production of the most intelligent citizen of which this nation is capable.

Recognizing that learning takes place when the situation is right, the background, the conditions, the processes, and the outcomes of education will, hopefully, develop a citizen capable of wise choices and worthy decisions. Our role as teachers is to set the stage for full participation of the student in the learning act and provide both encouragement and the setting where such development is expected.

DESIGNING THE RIGHT SITUATION

Right situations in learning do not happen by accident. They are the result of careful design. This design must include setting of objectives, selection of content, and description of appropriate attitudes.

WHAT DO WE MEAN BY OBJECTIVES?

In the right situation you have to be able to state in observable terms what the student should be able to do as a result of being there. For example, can he or she order objects in terms of size?

Can she or he identify variables in the environment, i.e., which factors in the environment can be continued and which can not? Can the students design experiences which would control some variables and allow others to be manipulated?

After constructing an inference, can the students demonstrate a way to test it?

HOW DO WE STATE OBJECTIVES?

Since objectives are statements defining what the student is expected to be able to do as a result of the lession, they should be stated in behavioral terms; i.e., using action verbs which would involve a student doing something which you can observe. For example, the student should be able to *order* the objects from smallest to largest.

A student may learn many other things from a lesson, but it is of prime importance that he or she acquire the behaviors and abilities stated in the objectives.

Educational objectives in the past have been rather vague and difficult to evaluate. Such objectives as "to appreciate" or "to understand" are useful in communicating the school's role to parents, but they are not very useful in the instructional program.

WHAT DO WE MEAN BY CONTENT?

Content is the vehicle used for giving students the opportunity to experience the activities of one or more of the processes of science. Thinking does not occur by itself. Thinking is the processing of information. Content and information are not ends within themselves. If content is equated as a body of knowledge, then it should lead to information. Processing information toward an interpretation is our goal.

Content
↓
Information
↓
Information Processes
↓
Interpretation

Content should be selected with respect for two factors:

A. Experience or behavior needed. For example, an aquarium might be used to provide students with an opportunity to:

- Observe environment
- Classify part of the environment
- Infer relationships
- Interpret data collected to test inferences

B. Availability of material suitable for the maturity level of the students.

WHAT IS A SUITABLE ACTIVITY?

To select activities, ask these questions:

- Does it involve all of the students?
- Is there interaction among the students?
- Is it suitable for the maturity level of the students?
- Can you identify expected student behavior?

Activities selected should include the following:

- Sources of information available for both you and your students. If sources of information are not available, should you question the activity's appropriateness for your students?
- What media and human resources are available and how are these related to the maturity level of your students?
- Which experiences will indicate performance abilities of your students? Diagnostic experiences should be performance measures to see what the students can already do and should also determine if they can perform given tasks as a result of the activities. These should be observable tests.

IMPLEMENTING THE RIGHT SITUATION

The right situation includes an appropriate mixture of students and teacher within the learning situation. To discuss the implementation of the situation, it may be useful to identify the role of the teacher and the role of the student.

WHAT IS THE ROLE OF THE TEACHER?

Is the teacher an essential factor in learning? In what way would the student's learning experience be changed if the teacher were not present?

Answering these questions requires you to think specifically about how the student's learning experience is changed by the teacher. An analogy that might be drawn is to liken a teacher to a director. When one considers a musical or a dramatic production, the director is responsible for a variety of tasks, such as setting the stage, diagnosing the actors' performances, guiding the actors to richer and more meaningful performances, securing resources when needed.

HOW DO YOU SET THE STAGE?

Setting the stage of students' learning experiences is a task of no small magnitude. This preplanning activity includes securing the students' materials, arranging them for convenience and accessibility. Much lost time results from poorly arranged classrooms.

If there is only one focus of attention in the classroom, are the students arranged so that all will have a front row seat? Or, are they arranged so that only a few can observe the event? Thinking ahead and anticipating student responses can add a desired dimension to a learning experience.

In setting the stage, the director is not only concerned with the props on the floor, but also gives thought to the background. It communicates a tone or atmosphere to the performance.

What is the tone of your classroom? Does its dreariness speak of your weariness? Does its dramatic splash of color reflect your sparkle and interest? Do your displays end with question marks or exclamation points? Our classroom reflects much of us. If we are the givers of information, we may tend to have many displays of that information in the room. If we are, however, directors of thinking, we will try to use displays to cause students not only to "look and see" but to "observe and ponder."

WHERE DO YOU START?

A director recognizes that each actor is an individual capable of deep, rich, and rewarding experiences. The director carefully listens to the rehearsal. He or she observes mannerisms, voice inflections, superficial role interpretations, and other key behavior. Then the director selects the appropriate means for helping the actor improve his or her performance. The director recognizes that "telling" the actor that a gesture was inappropriate will not do the job. Rather, with the actor, the director actually explores and practices better ways to move the hand, for example.

You as a teacher have a similar role. To identify those areas in which each of your students needs assistance, you start with a situation in which she or he must perform the behaviors described in your objectives. You:

- watch
- listen
- observe the variety of activities, then
- select those experiences that each student needs

The need for improving ability to infer, ability for self expression, or skill in manipulating apparatus may be indicated. All students will not have the same need, but all students have some needs. Using the learning situation to assist you in diagnosing those needs is a key to successful teaching.

HOW DO YOU GUIDE STUDENTS?

Just as a director finds "telling" of rather limited value, so do you. The "telling" approach to teaching began back in the Middle Ages when there were no sources of information other than the teacher. In our day we now have many sources for student experiences. Involving students in these experiences so that they — not you — are the star performers is a real challenge. This challenge can result in a rewarding success if we handle students' responses in such a way that they gain new respect for their abilities to deal with situations.

Some specific way to meet these challenges include the following:

- Let students decide for themselves the criteria they will use in observing rather than giving these criteria to them.
- Encourage students to try out their ideas rather than discuss the merits of the ideas

with them before they have a chance to use them.

- Let students take time to ponder, to grow, and to experiment rather than directing them immediately to their conclusions.
- Respond to students' explanations with additional questions such as, "How do you know?" or "Is that a reasonable idea?" rather than to agree or disagree with their explanations.
- Keep an open mind concerning students' responses rather than insisting on answers you have in mind.
- Direct students' thinking by introducing situations that "don't fit" or that may surprise, rather than telling the student that they didn't see the point.
- Keep students actively involved either physically or mentally rather than dominating the activity yourself.
- Provide students with experiences prior to expecting analysis of experiments and definitions of words rather than introducing vocabulary and calling for inferences before the experience.
- Base your opinions on what you see the students do, not on what you assume they can do.
- Continually involve all students in the activity by providing opportunity for them to express opinions rather than allowing the activity to become a demonstration monologue between you and one or two students.
- Pose questions designed to make students think rather than allowing them to give the answer you have decided is correct.
- When you draw an inappropriate response, probe its basis rather than simply telling the student he or she is wrong.
- Assist students in backing up and simplifying complex statements so other students will comprehend them. This is more effective than accepting a complex statement simply because it sounds good and is fairly adequate.
- Leave the student with the feeling there is more to come rather than finishing each science lesson with everything "all wrapped up" in a fairly neat bundle.

[illegible]

Rarely does a director work alone. When confronted with a new need, he or she seeks help. When you are faced with a new instructional need, where do you find help?

Sometimes help comes from facing the problem and trying the activity with your own students. Let them help you evaluate the solution to the problem. A student's criticism of a unit can provide very helpful insights. On other occasions, a teacher who has worked with the same or similar activities can be helpful.

Resource materials such as books and additional vertical file materials in the library can be important sources of help. For example, your librarian can assist you in identifying good biographies of scientists. These biographies can be very useful in picturing both the triumphs and disappointments scientists have experienced in their search for solutions to nature's puzzles. In short, as a director of student performance, your role is one of helping to add meaning to experience, richness to interpretation, and depth to the student's enjoyment of science.

[illegible]

Continuing the analogy of the students as actors, they are the ones who are in the spotlight of action, the ones on whom action is focused.

Within the context provided by a skillful teacher-director, students initiate action and accept the responsibility for their actions.

Students explore their environment, handling and manipulating it. They are also directed to explore the largely untried realm of thinking through relating events of their experiences, developing additional ideas about these events, and testing their ideas. Exploration of one's environment and thinking is extended through:

- evaluating deduction
- making mistakes
- improving one's approach to seeking

In this way, students learn to manipulate and control aspects of their environment through guided explorations.

Such an approach might be described as simply learning to do by doing. This is not quite complete. The student learns to do by guided doing. The teacher is the one who structures the learning situation, the one who carefully watches and listens to the learning activities, the one who stimulates and encourages the learner, the one who provides background and direction for the learner through skillful questioning.

Together, the teacher and the student share the joy of intellectual discovery, increasing their awareness of and their ability to use structured methods of asking questions and seeking answers.

HOW CAN YOU BE SURE?

WHAT DO YOU EXPECT TO SEE?

You expect to see student behavior change, indicating that the objectives you have established are being accomplished. Are the students involved in the activities without teacher interference? Do they make suggestions for investigating new problems generated by an activity? Are the students demonstrating changed thinking behavior? Do their interpretations indicate they have processed the information of their experiences, or are their interpretations mere repetitions of raw information?

WHAT DO YOU SEE?

You see a greater interest in discovery and students eager to study science each day. You see growth in the student's ability to sift information and to make justifiable generalizations. You also see evidence that students make increasingly sophisticated interpretations of their experiences, demonstrating increasing degrees of independence. You also can see the processes of learning carried over into other subject areas as the year progresses.

Activities which do not meet the needs of your students may be replaced by more relevant innovations of your own design. You should notice which questions result in interaction in the classroom among the students rather than in constant direction by the teacher to the students.

WHAT EVIDENCE DO YOU ACCEPT?

Use your daily observations as part of the evaluative feedback about the activities as you had them planned. Note where differences arose in the planned work. Make notations for future planning to alleviate these difficulties. Determine the proficiency of the individual students as they complete the activities and related work. If an activity is not relevant to the development of your objectives or has no meaning for your students, consider a change.

Information gained from standardized tests should be considered in relationship to the task they measure. Does the student have to recall many specific bits of information? If so, the test is an appropriate measure of the students' ability to memorize. On the other hand, does it require the student to do something with information, i.e., construct a graph and make predictions from it? If so, it is an appropriate measure of a science program designed to teach the student to make interpretations.

Most currently available tests do not measure inquiry; they test recall of facts. More emphasis should be placed on performance tests given after each activity. When the instructional objectives include written expression of ideas, paper and pencil tests are appropriate. Tests should be keyed to the performance expected of the student.

WHAT DOES YOUR COMMON SENSE TELL YOU?

Finally, a highly important source of information is your own judgment. Objective tests are useful, but your common sense should never be ignored.

PROCESSES·PROCESSES·PROCESSES·PROCESSES

Observing · Classifying · Measuring · Communicating · Obse

PROCESSES·PROCESSES·PROCESSES·PROCESSES

·Recognizing Space-Time Relations·Controlling Variables·

PROCESSES·PROCESSES·PROCESSES·PROCESSES

Inferring·Formulating Hypotheses·Defining Operationally·

Sample Units

PROCESSES·PROCESSES·PROCESSES·PROCESSES

Interpreting Data·Recognizing Number Relations·Predictin

PROCESSES·PROCESSES·PROCESSES·PROCESSES

·Recognizing Number Relations · Formulating Hypotheses ·

PROCESSES·PROCESSES·PROCESSES·PROCESSES

·Observing · Classifying · Measuring · Communicating · Obse

UNIT FOR PRIMARY LEVELS INCLUDING KINDERGARTEN

[illegible]

Objectives

At the end of the unit, the student should be able to:

- Identify and describe objects on the basis of similarities and differences
- Distinguish among objects by using the sense of sound, taste, smell, and touch
- Demonstrate when one sense is more important than others in clarifying observations
- Demonstrate the use of senses to reach a conclusion
- Group objects according to sound, taste, smell, and touch

Key Ideas

- The five senses are sight, hearing, feeling, taste, and smell.
- The receptors of sight are in the eye; the receptors of hearing are in the ear; the receptors of feeling are in the skin; the receptors of taste are in the tongue; the receptors of smell are in the nose.
- The senses are closely associated with one another.
- Learning about the environment occurs through the use of the senses.
- Observation involves the use of all the senses.

Processes Emphasized in the Unit

- Observing
- Communicating
- Classifying

Rationale

The varied activities which follow are designed to involve the use of the senses and to point out for the child the particular functions of the senses. As students progress in the educational program, they need to make use of all of their senses in answering and asking questions. Children learn primarily by direct experience — hearing, seeing, feeling, smelling, and tasting — much as does the scientist. These sensory experiences are the basis for building all understandings.

The process of observation includes the use of all the senses. Scientists develop the skill of observation — they make use of all the senses. Continuous activities in observation will help children to realize how their senses are used in learning and will encourage them to observe, to record, and to report more accurately. The skills acquired will aid the children to understand better what they may be taking for granted and will lay a sounder foundation for future study, and for all learning.

References for the Teacher

Blough, Glen O., and Schwartz, Julius, *Elementary School Science and How to Teach It.* 5th ed. New York: Holt, Rhinehart and Winston, Inc., 1974.

Carin, Arthur, and Sund, Robert B. *Teaching Science Through Discovery*. 3rd ed. Columbus, Ohio: Charles E. Merrill Books, Inc., 1975.

MacCracken, Helen Dolamn, et al. *Science Through Discovery*. Teacher's Edition, Grade 1. Dallas: The L. W. Singer Co., Inc., 1968, o.p.

Victor, Edward, and Lerner, Marjorie S., *Readings in Science Education for the Elementary School*. New York: The Macmillan Company, 1967.

Learning Experiences

Initiating the Study

Place a baseball, a pencil, a chalkboard eraser, a flower, a whistle, and an orange sliced in half on a table where all of the children can see.

Hold up the baseball and ask the children to describe it. Keep a record of what the students notice about this object. Ask: "How does this object feel? Can you find something in the room that feels the same way? How does it smell? How does it sound?"

Hold up each of the other objects and ask the same questions. When the orange is selected, ask one of the children to describe the taste. Let another child taste the other half of the orange and describe how it tastes to him or her. Have the children compare the descriptions of the taste of the orange.

Activity 1

Ask a child to describe one of the objects on the table or an object in the room which the children name as being similar to the ones on the table. The other children are to identify the object which the child describes. If the child describing the objects does not mention the size or shape of the object, ask how large it is and how the object feels, or sounds, or smells, or tastes (if appropriate). Ask leading questions to gain this information. (Caution, of course, must be taken in observing taste.)

Activity 2

Blindfold a child and let another give an object to him or her to describe. Ask, "How does it feel? What is the shape of the object? What is the size of the object? Can you hear it? Tap it on the desk. What kind of a sound does it make? How does it smell? Can you identify the object?" Let the children take turns being blindfolded and asked to describe and identify.

Activity 3

Blindfold a child again and ask him or her to describe and identify an object or event by using the sense of smell alone. Light a candle; burn a piece of paper; peel an orange, apple, lemon, or banana; hold paste, perfume, or an onion to his or her nose. Let the children take turns being blindfolded and asked to describe the odor and identify the object or event.

Activity 4

Show the children two identical clear bottles — one filled with water, the other filled with white vinegar. Ask the children to describe what they see. Record the various observations. Ask:

"Do you think these bottles might be filled with the same liquid?
Can we tell by looking?
What could we do to find out?"

Someone is sure to suggest that smelling the liquid might help. Demonstrate the safe way to smell a substance by keeping the face a safe distance from the glass. Hold the glass in one hand, and with the other hand waft the fumes toward the nose. Chemists use this procedure in investigating odors.

Allow each child to smell each of the liquids. Even though they look alike, the liquids are not the same. We can tell by our sense of smell.

Activity 5

Show the children two glasses filled with ginger ale. To one of the glasses of ginger ale add red food coloring. Proceed as in Activity 4.

"Do they look the same?
Do they smell the same?"

Here are two things that look different but smell the same. Compare the results of Activity 3 and Activity 4. Discuss the results of the activities and present a fourth possibility — two things look the same and also smell the same. Four possibilities can be considered as shown in the table:

Look alike Smell alike	Look alike Smell different
Look different Smell alike	Look different Smell different

After a discussion, the children should infer that what something looks like does not necessarily indicate what it smells like; what something smells like does not always indicate what it looks like.

Activity 6

Place the following on a table: salt, sour pickle, bitter chocolate, sugar, and lettuce. Group the children into four groups. When each group comes to the "tasting table," have each child blindfolded. Each of the group tastes the substances placed there. Ask them to describe the taste. "Does it taste bitter, sweet, or sour? Does it have a taste? Can you tell what you are tasting?"

After the children have described the taste and have attempted to identify what they have tasted, have them take the blindfolds off to check their conclusions. (Warn the children never to taste something unknown to them unless they are being supervised.) Follow the same procedure with the next two groups. Allow the children who have been to the table to remain there as the other children participate in the activity. When the last group comes to the table, direct the children in the group not only to blindfold themselves, but to hold their noses as they taste the substances. Ask:

"How does this taste to you?
Can you taste as well when you cannot smell?"

Activity 7

Ask the children to close their eyes and lay their heads on their desks for two minutes and listen for sounds. Ask each child to make a mental note of what he or she hears. Have the children describe what they heard and record all the different observations of sound.

"Which of the sounds recorded were made by animals? By machines? By the wind? Which of the sounds were loud sounds? Soft sounds? High sounds? Low sounds? Can we hear better when sounds are closer or farther away from us? Why?

Ask each child to rub together gently the tips of the index finger and the thumb of one hand while the arm is extended so the fingers are as far as possible from the ear. Ask:

"Do you hear the sound of the fingers rubbing?"

Hold the fingers close to the ear and rub. "Now do you hear the sound?"

Activity 8

Arrange three boxes in a row on a table. The boxes should be large enough so that the children can drop objects into them. In the bottom of Box 1, place a pie tin or china plate; in Box 2, newspaper wadded up and covering the bottom of the box; in Box 3, nothing. Ask four or five blindfolded children at a time to come to the boxes, and tell each to drop a piece of chalk, a checker, or a marble into one of the boxes. When all the children have participated, discuss what they think they know about each of the boxes.

Extend the activity by dropping other small objects into the same or different boxes.

After the practice with the various sounds, ask the children to describe the sounds they heard.

Activity 9

Divide the class into four groups. Place several of the objects listed in the materials section, p. 21 (sandpaper, emergy board, terry cloth, etc.) on each of four tables. Be sure there is a variety of textures on each table. Assign a table to each group, and let each child feel the objects on the table. Ask the children to describe how the objects feel. They may respond with words such as *bumpy, soft, hard, smooth, rough*, and so on. Encourage as many adjectives as possible in describing the objects.

Activity 10

Suggest how the objects in Activity 9 could be arranged according to the words the children used to describe them. Some categories might be those that felt smooth, rough, bumpy, or slick.

Appraisal

1. Take the class on an observation walk.

   When the class returns, initiate a discussion about the walk. "What different things did you observe? Describe them." Make a chart on the chalkboard as below.

Smell	Touch	Sight	Sound	Taste

   Chart the different responses on the chalkboard. If students mention they saw a car and heard a car, ask if the car could be identified by the sound it made. If someone mentions a bird, ask whether the bird was seen or heard first. If students say they heard a man talking, ask how they could be sure it was a man. Ask questions to test their observations.

2. Place the following on a table: candle, lemon, orange, baseball, pencil, head of lettuce, and head of cabbage. Allow the children to observe all the articles there for about 30 seconds. Then let the children come to the table one at a time. (Before each gets to the table, blindfold him or her.) Give each child one of the articles to identify.

3. Repeat Activity 5, substituting salad oil for the ginger ale.

References for the Student

Bond, M. *A Bear Called Paddington*. Dell Publishing Company, Inc., New York City, 1968

Branley, Franklyn M. *High Sounds-Low Sounds*. New York: Thomas Y. Crowell Company, 1967, unpaged. The nature of sound with suggested activities.

Branley, Franklyn M. *Weight and Weightlessness*. New York: Thomas Y. Crowell Company, 1971, 34 pp.

Butts, David P., and Addison E. Lee. *Watermelons*. Austin, Texas: The Steck-Vaughn Company, 1968, o.p.

Chester, Michael. *Let's Go On A Space Shuttle*. New York: G. P. Putnam's Sons, 1975, 45 pp.

Dickson, G., and B. Bova. *Gremlins Go Home*. New York: St. Martin's Press, Inc., 1974.

Dukas, P. *The Sorcerer's Apprentice*. New York: Japan Publications Trading Company, (U.S.A.) Inc., 1971.

Earle, Olive L. *Praying Mantis*. New York: William Morrow & Company, Inc., 1969, 48 pp. A good reference for children with questions.

Branley, Franklyn M. *Rockets and Satellites*. New York: Thomas Y. Crowell Company, 1970, 34 pp. Space Travel for Beginners.

Stone, A. Harris. *Science Projects That Make Sense*. New York: Dutton, 1971. Leads children to probe simple problems through use of the five senses.

Wannamaker, Bruce. *We Visit the Farm. We Visit the Zoo*. Chicago: Childrens Press, 1976.

White, Laurence B. *Investigating Science With Rubber Bands*. Reading, Mass.: Addison-Wesley, 1969. Activities that use rubber bands as the basic material.

White, Laurence B. *Investigating Science with Paper*. Reading, Mass.: Addison-Wesley, 1970. Activities that use paper as the basic material.

White, Laurence B. *Investigating Science With Nails*. Reading, Mass.: Addison-Wesley, 1970. Activities that use nails as the basic material.

Human Resources

Invite a teacher of blind children to talk to the class.

Materials

Baseball, pencil, chalkboard eraser, flower, whistle, orange, candle, apple, lemon, banana, paste, perfume, onion, sugar, salt, bitter chocolate, pickle, lettuce, cabbage.

Two identical, clear bottles — one filled with water and one filled with white vinegar.

Two identical clear glasses filled with ginger ale; red food coloring added to one of the glasses.

Pie tin or china plate, a small piece of chalk, a checker, or a marble for each child.

Sandpaper, emery board, terry cloth, wax paper, cotton, smooth rock (polished marble), rough rock (granite), a mirror, golf ball, tennis ball, facial tissue, paper toweling, and as many different kinds of textures as can be found in the classroom.

MAGNETS

Objectives

At the end of the unit, the student should be able to:

- Identify objects which possess magnetic properties by demonstrating their effect on other objects
- Identify an object of any shape and size which could possess magnetic properties
- State and demonstrate a way for determining the relative strength of a magnet
- Demonstrate that a magnet exerts a force on another magnet

Key Ideas

- Magnets exert both a force of attraction and a force of repulsion on other magnets.
- On objects of certain types of metal, a magnet will exert a force of attraction only.
- The earth has the properties of a magnet.
- Forces between magnets and forces between magnets and other objects can be observed even when there is no direct contact.
- The regions of strongest magnetism on opposite parts of a magnet are called magnetic poles.

- The closer an object is to one of these magnetic poles, the stronger is the force between them.

- Breaking or cutting a magnet in two parts results in two magnets, each with two magnetic poles.

- Like poles on a magnet exert a repelling force on each other, and unlike poles attract each other.

Processes Emphasized in this Unit

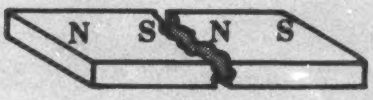
Observing, classifying

Rationale

Magnetism is one of the fundamental natural forces present in our environment which continually affects the activities of humans in one way or another. Strangely enough, however, only relatively few materials possess strong magnetic properties. The only common metals which ordinarily interact with magnets are either iron, nickel, or cobalt. Since iron is the most abundant of these three metals, it is not likely that materials made from cobalt or nickel will be found in many ordinary objects. It is for this reason that the experiences found in this unit pertain only to objects made from iron. It should be noted, however, that the five-cent piece used in Canada is solid nickel and can be obtained easily. Metallic alloys have been made using non-magnetic materials mixed with either iron, nickel, or cobalt, and these alloys often exhibit very strong magnetic properties. Liquid oxygen also interacts with magnets even though it is not considered a metallic substance. Those materials which interact with magnets are usually called *ferromagnetic*.

Why some materials are magnetic and others are not is a question still not answered to the satisfaction of scientists. It has been observed that magnetic effects are always associated with moving electric charges. Thus it is assumed that the magnetic properties of the ferromagnetic materials are the result of some sort of movement of electric charges in their atomic structure.

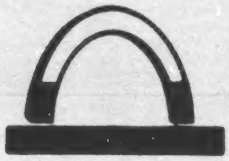
If you put a magnet into a box of paper clips, you find that it picks up many clips at each of its ends and relatively few in the center. The regions of strongest magnetism are called magnetic poles. All magnets have two such poles. By placing the two ends of two magnets near each other, a force of attraction or repulsion is experienced. Thus the law of magnets can be stated as follows: "*Like* poles repell each other, and *unlike* poles attract each other."

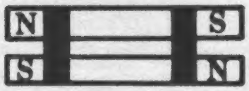


It is not possible to produce a single magnetic pole. If you try to isolate the "north" seeking pole from the "south" seeking pole by cutting or breaking a bar magnet in two, a new "north" and a new "south" pole is formed at the break. This breaking then results in two magnets, each with a north and south pole. This process may be repeated until the magnet is only a very small size — about the size of a molecule. There would still be two poles.

Some of the magnets used in this unit are of the ceramic variety. Ceramic magnets are made by mixing iron powder with certain other ceramic compounds and then submitting the mixture to a very high pressure in the presence of a very high magnetic field. A recently developed alloy of manganese and bismuth produces a magnet several times stronger than the alnico type. This new material seems to hold its magnetism much better and can easily be cut and worked into intricate shapes.

The activities of this unit enable the child to observe, at a very elementary level, some of the characteristics of magnets. The student will observe the actions and interactions of one or more magnets with some of the more common everyday materials of his or her environment.





Magnets are easily destroyed if not handled properly. When two magnetic poles of a magnet are close together, as they are in a "U" or in a horseshoe magnet, a piece of iron should be placed across both poles when the magnet is not being used. This shorting bar (keeper) is removed when the magnet is being used. In the case of bar or cylindrical magnets, they should be stored in pairs by placing the north seeking pole of one in direct contact with the south seeking pole of the other. Also avoid jarring the magnets — this tends to decrease their magnetic strength.

References for the Teacher

Krauskopf, Konrad, and Arthur Beiser. *Fundamentals of Physical Science*. New York: McGraw-Hill Book Company, 1966, Chapter 13, pages 184-197. An easy-to-read exposition on the properties of magnets including basic theory and applications. The relationship between moving electric charges and the resulting magnetic field is discussed.

Stollberg, Robert, and Faith F. Hill. *Physics—Fundamentals and Frontiers*. Boston: Houghton Mifflin Company, 1965, pages 371-387.

An excellent up-to-date reference to the subject of magnets which discusses, in easy-to-read language, the basic laws, theory, and properties of magnets. Well illustrated.

Learning Experiences

Initiating the Study

Group the class in fours and give each group a box containing the following items: an unmarked magnet, a box of paper clips, a small iron nail, an iron screw, a brass screw, an iron washer, a marble made from glass, an eraser, a wood pencil, a copper penny, a crayon, a piece of cloth, a small piece of aluminum wrap, and any other materials easily available. (This list simply offers suggestions for what might be included in the box. Any group of several items which includes both magnetic and non-magnetic materials is appropriate.)

Ask the children to place the materials from the box in two groups — one group containing objects which are attracted to the magnet and one group containing objects which are not attracted to the magnet.

After collecting the magnets from the children, give each of them a magnet of a different shape. Ask them if the groups of objects are the same when they use this magnet.

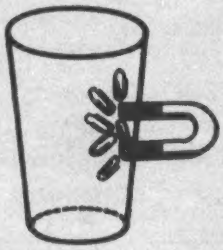
At this point each child will have had some experience with magnets. Now discuss with the class the observed results of this initiating activity. Let the children list *their* observations. For example, some will say that only certain kinds of objects are attracted by the magnet. Others might say, "Some objects stick to the magnet and others do not stick."

Activity 1

On the teacher's desk place two metallic bars of similar size and shape, one should be a bar of unmagnetized iron and the other should be a bar magnet. Be sure that any magnet used has the marked ends covered. Ask class members to tell how they would find out whether or not one of the objects is a magnet. The children will probably respond in terms of their experience with magnets during the initiating phase of the unit. They may suggest that each object should be tested to see if it will pick up iron nails or paper clips. After the children have made their responses to the question, select two children to step forward and perform the tests suggested by the class. Discuss with the class the observed results by asking them to give reasons why one of the objects is a magnet and the other is not. The entire class should agree on the choice of which object is the magnet.

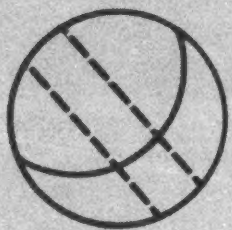
Activity 2

Have a child place some paper clips in a glass and ask, "Will the paper clips be attracted to the magnet through the glass?" After a few guesses have been made, let a child come to the front of the room and manipulate the paper clips by moving a magnet around on the outside of the glass.



Now have a child pour water into the glass and see if the water has any effect on the magnet's attraction for the paper clips. Now ask the class to place various materials between the magnet and the paper clips to see if the magnet can exert its effect through those objects. Discuss with the class the idea that magnetic effects can be observed to "go through" non-magnetic materials.

Activity 3



Pick up a ping pong ball which has a magnet inside and ask, "Is this a magnet?" Perhaps some of the children will respond with a quick "no," but most will say that it should be tested to see if it is a magnet. After a few student responses, ask a youngster to come before the class and perform the test (have an open box of paper clips on the table). Make sure that the ping pong ball is tested over its entire surface.

Next, pick up a screwdriver which has been "stuck" against a strong magnet and ask, "Is this a magnet?" By this time the children should have caught on. Their response most likely will be, "We have to test it to find out." Have a child come forward and test to see whether or not the screwdriver can be classified as a magnet. A screwdriver which has been stuck to a magnet usually will exhibit magnetic properties by attracting paper clips or some other ferromagnetic material. (You may wish to have two or three screw drivers available to demonstrate that all screw drivers are not magnets!)

Now hand each group of four children a box containing the following magnets: circular, "U"—shaped, rectangular, horseshoe, cylindrical, and bar. None of these magnets should be marked to indicate their polarity. Ask the children to test each one and see if they are magnets. These tests should be performed quickly at their seats. Ask the children to comment on their observations. They should mention that the magnets are in many different kinds of shapes. Ask, "Does the shape of an object determine whether or not it is a magnet?" The children should respond quickly with a "no!" Give the children a few minutes to "play" with the various-shaped magnets.

Activity 4

Place several magnets of the same shape but of different sizes and strengths on the children's work area. Three bar magnets or three horseshoe magnets will do. The middle-sized one might be the strongest; the smallest, the next strongest; and the largest, the weakest. Ask the children how they would determine whether or not the objects are magnets. The class should respond with a statement like, "See if they will pick up nails or paper clips." Now ask which of the three objects is a magnet. Keep asking this question until some student picks up the magnets and tests them in some acceptable manner.

Now, with this child still at the front of the room, ask, "How can you tell which one is the strongest?" Hold up the large magnet as you ask this question. Some students may infer that the largest magnet is the strongest. Put the large magnet down and hand the small one to the child still at the front of the room; suggest that he or she make a long chain of paper clips (as long as possible) by placing only one paper clip in contact with the magnet and the second one in contact with the first, and so forth. Ask the children to count along with you as you count the number of clips supported by the smallest magnet. Next pick up the largest magnet and ask the class to predict how many paper clips it will support. Some children may say, "That one will hold up hundreds." Some may say, "Test it and see." Allow the children time to find out that it will actually support only a very few paper clips. Now select a student who has not yet participated in the discussions and ask him or her to repeat this experiment using the middle-sized magnet.

Now ask, "What can you now tell about these three magnets?" Ask, "Is it possible to tell what a magnet's strength really is by its size?" The obvious answer is "No." Ask, "How can you tell the strength of a magnet?"

Activity 5

Ask a child to hold a bar or cylinder-shaped magnet in a horizontal position and have a classmate find out how many paper clips it will hold at each of the two ends and in the middle. The children should observe that the magnet is strongest at the ends and weakest in the middle.

Activity 6

Give each group of two children a pair of unmarked magnets. Ask them to bring the two ends close together and observe what happens. (You may have to remind the children that they observe with *all* their senses including their sense of feeling.) Now ask the children to tell what their observations are. Some students will report that the two ends pushed away from each other. Suggest that each student repeat the experiment several times to be sure of his or her observations.

Activity 7

Have the students take one of the cylindrical magnets and place it on a level surface (for example, the floor). Ask, "What do you observe when another magnet's end is brought near the end of the one on the floor?" The students should report that the magnet on the floor moved.

Appraisal

1. Give each child a magnet and an object which is not a magnet. Ask him or her to determine which of the two objects is a magnet.

   If the child performs a test to see which object will pick up a paper clip or some other iron object, he or she should be given credit for a correct response — provided, of course, the correct object is selected as the magnet.

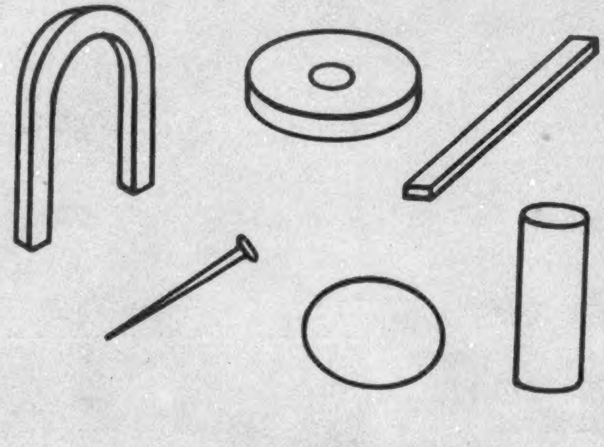
2. Give the child two magnets, one of which is in the shape of a cylinder. Ask him or her to demonstrate how one magnet can cause the other to move.

   The child should be given credit for a correct response if he or she puts one magnet in a position to move freely (such as the cylindrical magnet on some level surface) and brings the other magnet close enough to it to cause a slight movement.

3. Give the child two magnets, one strong and the other weak. Ask him or her to determine which one is the stronger.

   If the child placed paper clips on the ends of both magnets and determines the stronger by the larger number of paper clips it will support, he or she should be given credit for one correct response.

4. Prepare a sheet with drawings like those shown below and give each child a copy. Ask him or her to circle all the shapes which might be a magnet.



   The child should be given credit for each picture he or she circles. Each shape could be a magnet. One cannot tell whether an object is a magnet by its shape alone.

References for the Student

Darwin, Leonard. *What Makes a Telephone Work?* Boston: Little, Brown, 1970.

Knight, David C. *Let's Find Out About Magnets*. New York: Franklin Watts, Inc., 1967, 55 pp. Clearly written subject matter with activities — easy.

Lieberg, Owen S. *Wonders of Magnets and Magnetism*. New York: Dodd, Mead & Company, Inc., 1967, 64 pp. o.p. Discovery, uses and general information.

O'Connor, Jerome J. *The Telephone: How It Works*. New York: Putnam's, 1971.

Pearce, W. E. and Aaron E. Klein. *Transistors and Circuits: Electronics for Young Experimenters*. Garden City, NY: Doubleday, 1971.

Podendorf, Illa. *The True Book of Magnets and Electricity*. Chicago: Childrens, 1972. This book is well illustrated; reading level is appropriate for lower elementary children.

Ruchlis, Hy. *The Wonder of Electricity*. New York: Harper & Row, Publishers, 1965, 218 pp. o.p. Detailed, broad in scope; a good resource.

Sacks, Raymond. *Magnets*. New York: Coward-McCann, Inc., 1967, 45 pp. Easy.

Schwartz, Julius. *It's Fun to Know Why*. New York: McGraw-Hill, 1973. Investigations with bread, iron, paper, and other everyday materials.

Schwartz, Julius. *Magnify and Find Out Why*. New York: McGraw-Hill 1972. The reader discovers the fascinating details of many everyday materials, and learns to observe more scientifically while doing so. Easy reading.

Seeman, Bernard. *The Story of Electricity and Magnetism*. New York: Harvey House, 1967, 123 pp. Contains experiments; shows

relationship of electricity and magnetism illustrated.

Sooten, Harry. *Experiments with Electric Currents*. New York: W. W. Norton & Company, Inc., 1969, 88 pp. o.p. The fundamentals of electricity. *Experiments with Static Electricity*. New York: W. W. Norton & Company, Inc., 1969, 86 pp. o.p. Simple experiments.

Stone, A. Harris, and Bertram M. Siegel. *Turned on: A Look at Electricity*. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1970, 64 pp. Experiments, making equipment, and discoveries.

Zim, Herbert S. and James R. Skelly. *Telephone Systems*. New York: Morrow, 1971.

Human Resources

Perhaps the best source of assistance for most elementary teachers is to be found within the school system. The high school science teacher who teaches physical science can suggest activities involving magnetism. Quite often, he or she can provide you with equipment needed to perform experiments.

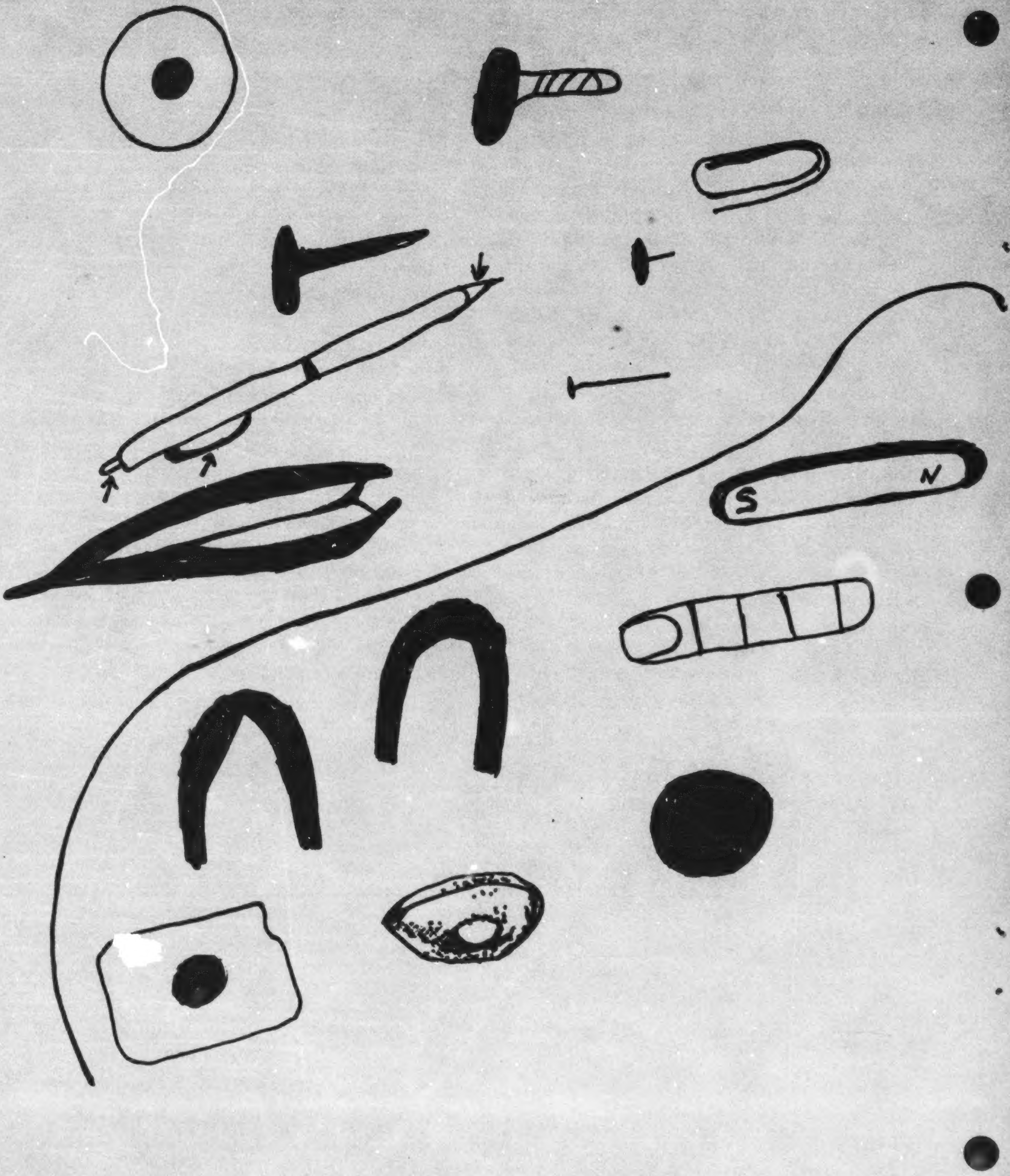
Do not overlook the possibilities of having a high school physics student visit your class to give a demonstration.

In most communities, the local radio and television repair person can give aid in locating magnets. Don't be afraid to ask technical questions. In most cases, they will be honored at being asked to help.

Materials

The materials listed below can be obtained from any supplier of science equipment. The high school science teacher can help you order items. Some of the items can be obtained from a local hardware store and from a telephone company. The quantity of magnets recommended below should be sufficient for about 32 students.

Cloth, paper clips, nails (iron and aluminum), screws (iron and brass), marbles, pennies, aluminum foil, washer (iron), iron bar or rod (such as a magnet you have on hand), glass, screwdriver (magnetized), 15 cylindrical magnets (9 x 125mm), 15 (iron) cylindrical magnets (15 x 180mm), 15 rectangular ceramic magnets (1 3/8" x 1 3/8" x 7/16"), 15 circular ceramic magnets (diameter-40mm, thickness-7mm), 30 bar magnets unmarked (25mm x 19mm x 13 mm), 15 plastic spheres with alnico magnet imbedded (1½" diameter) used in the program of the Earth Science Curriculum Project (ping pong ball), 24 "U"-shaped magnets of different strengths and sizes (eight of each size are needed).



A first grade child drew these pictures after being given some magnets to play with. No instructions were given.

UNIT FOR UPPER PRIMARY AND INTERMEDIATE LEVELS

[redacted]

Objectives

At the end of the unit the student should be able to:

- state a definition of force, such as, a force is a push or pull
- apply the rule that when forces are of the same size, but in opposite directions, an object is not moving
- apply the rule that some forces are greater and some are less than others
- apply the rule that when forces in opposite directions are not balanced, an object will move

Key Ideas

- Forces can be in any direction; all forces have magnitude.
- Forces may be represented by arrows pointing in the direction of the force.
- The arrows showing direction and amount of forces may be referred to as vectors.
- The length of the arrows will represent the amount of the force.
- Most of the forces that act on an object are in contact with it; but those that act on an object without being in actual contact with it are the pull of the earth, magnetic fields, and electricity.
- An object remains at rest unless an unbalanced force is placed on it.
- The same force can have different effects on different objects.
- The mutual forces of two objects on each other are always equal and in opposite directions.

Processes Emphasized in the Unit

Communicating, observing

Rationale

Students probably are all familiar with activities similar to those described in this unit; however, they probably don't recognize the scientific implications. Some of the activities do not attempt to show all of the forces that are involved. Those which are relevant to the concept being developed and those which can be understood easily by children of primary level are introduced.

All the activities involve forces which are in contact with an object with the exception of those demonstrating the pull of the earth, the ones which cause objects to fall earthward.

If the teacher prefers to use the word *arrow* rather than *vector* to represent direction and amount of forces, he or she need not introduce the word *vector* at all.

References for the Teacher

Althouse, Rosemary and Cecil Main, Jr. *Science Experiences for Young Children*. New York: Teachers College Press, Columbia University, 1975. A box of 10 teacher booklets containing activities for primary-level children on colors, food, magnets, wheels, pets, water, seeds, air, senses, and human growth.

Cotler, Harold I. *Encyclopedic Deskbook of Teaching Ideas and Classroom Activities*. New York: Parker Publishing Company, Inc., 1977.

De Vito, Alfred and Gerald H. Krockover. *Creative Sciencing*. Boston: Little, Brown and Company, 1976. A wide variety of teaching ideas and activities to stimulate creativity in elementary school and junior high school children.

Friedl, Alfred E. *Teaching Science to Children, The Inquiry Approach*. New York: Random House, 1972. Features a large array of hands-on science activities for elementary-school children.

Hill, Dorothy M. *Mud, Sand, and Water*. Washington: National Association for the Education of Young Children, 1977.

Hone, Elizabeth B., Alexander Joseph, and Edward Victor. *A Source Book for Elementary Science*. New York: Harcourt Brace Jovanovich, 1971. A very extensive collection of science activities, with specific instructions.

Lindberg, Lucille and Rita Swedlow. *Early Childhood Education: A Guide for Observation and Participation*. New Jersey: Allyn and Bacon, Inc., 1976.

Mark, Steven J. *Source Book of Experiments for the Elementary Grades*. New York: Vantage Press, 1970. Numerous activities to supplement a basic science program.

Munson, Howard R. *Science With Simple Things*. Belmont, Calif: Fearon Publishers, 1972. Fifty-three interesting activities with such common materials as rubber bands, paper clips, and milk cartons.

Neubauer, Peter. *The Process of Child Development*. New York: The New American Library, Inc., 1976. Bringing together the major contributions of 17 renowned authorities, this is a timely overview of one of the most rapidly developing frontiers of human knowledge.

Resnick, Robert, and Halliday, David. *Physics: Part 1*. New York: John Wiley and Sons, Inc., 1966, pp. 82-89. These authors give an explanation of Newton's three laws — the law sometimes called the law of inertia; mass, his second law; and his law of motion — and the relationship of each law to forces.

Rieger, Edythe. *Science Adventures in Children's Play*. New York: Play Schools, 1968. o.p. Easy investigations and study trips to stimulate young children's curiosity. For preschool and primary-level teachers.

Sharp, Evelyn. *Thinking is Child's Play*. New York: Avon Books, 1969. A practical application of Piaget's theory to simple diagnostic games for the classroom or home. Preschool and primary-level emphasis.

UNESCO, *New UNESCO Source Book for Science Teaching*. New York: UNESCO, 1973. Contains many science activities. Strong on how to improvise equipment from common materials.

Learning Experiences

Initiating the Study

Before beginning these activities, place a spring balance where the students can examine and handle it.

Say, "Look at the spring balance." (Hold it up). "Is there anything pulling on it? How do you know? (The point is at zero). Pull down the hook with the finger. Ask, "What is different now? Was there a push or a pull to make this change? In what direction was this pull? How can we draw a picture showing this pull?" (Draw two or three of their responses on the board). Have the class agree on a convenient way of representing pulls — (simple arrow). "In what direction was the pull?" (Downward). Draw Figure 1 on the board.

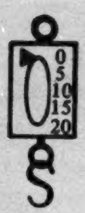


Fig. 1

"We can use another name for this arrow, which is *vector*." (Write the word *vector* on the board).

Tie an object such as a piece of a brick onto the hook of the spring balance. Ask, "Is there a pull exerted on the spring balance?" (Yes). "How do you know?" (The point moved from zero). "In what direction is the pull?" (Downward). "How can we draw a vector or arrow to show this?" (On the board draw the spring balance as seen in Figure 2. Ask one pupil to draw the vector or arrow).

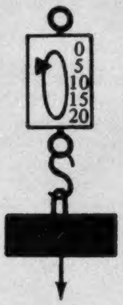


Fig. 2

Put another such object on the first weight. Ask, "Is the pull exerted on the spring balance the same as it was with one weight? Is it greater? Less? How can you be sure?" (The point moved more). "In what direction is this pull? If we draw the length of an arrow to show how much pull is exerted, will this vector be the same length, shorter, or longer than the one with only one weight on the spring balance?" (Longer). "In what direction will the vector be drawn?" (Ask one student to draw this vector). The completed sketch will appear as show in Figure 3.

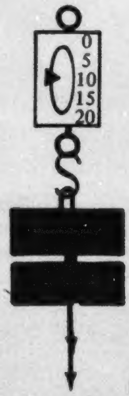


Fig. 3

Remove one of the weights. "Is there any pull on the remaining weight?" (Not the spring scale). (Yes). "How do you know?" If we cut the string holding the weight, what will happen?" (Demonstrate). "Why did it fall downward?" (If a student says, "Gravity," simply say, "The earth's pull causes objects to fall downward.") Ask one student to draw a vector (arrow) and label it "Earth's Pull."

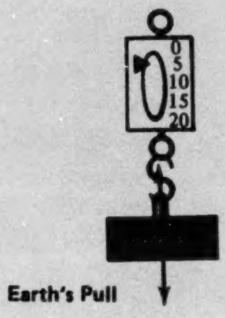


Fig. 4

Replace the weight on the hook. "Is there any other force or pull on the weight now?" (Yes) What is it? What keeps the weight from falling to the earth as it just did?" (The pull upward of the spring balance). (Ask one student to draw this vector.) Ask, "How many forces or pulls are on the weight now?" (Two) "What are they?" The completed sketch will appear as shown in Figure 4.

Activity 1

The purpose of Activity 1 is to show that forces have direction and may be horizontal, vertical, or diagonal; that there are forces in opposite directions acting on each other; and that the same force may have different effects on different objects (masses).

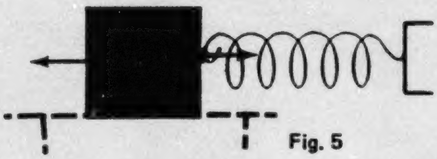


Fig. 5

Attach a spring that stretches easily to a piece of brick. Pull the spring horizontally until it stretches but does not move the brick. Ask, "Is there any force on the spring? What is the force? How do you know?" (The spring is stretched). "If we place an arrow in the direction of the force, how will we draw it? Is there any other force on the spring?" (The piece of brick). "In what direction is this force?" Draw the spring and both vectors (arrows) on the board. "How can we make the vectors show forces of the same amount?" (Make them the same length). The completed sketch is shown in Figure 5.

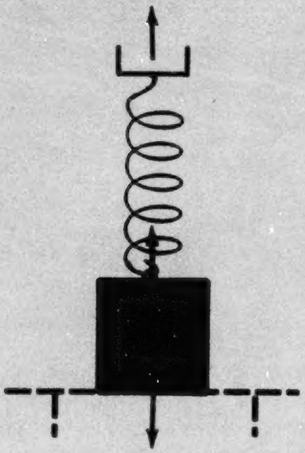


Fig. 6

Pull the spring to a vertical position, with the spring stretched the same amount as it was in a horizontal position. (Brick lying on table). Ask, "Is there more force on the spring now? Less? The same amount? Where are the forces?" Show these forces with vectors. Draw the spring on the board and ask one student to show the direction of the forces with vectors (arrows). The completed sketch is shown in Figure 6.

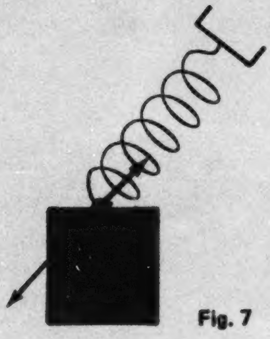


Fig. 7

Pull the spring to a diagonal position, with the spring stretched the same as it was in the horizontal and vertical positions. Ask, "Are there any forces on the spring now? What are they? In what direction would we draw the vectors?" Draw the spring on the board and ask one child to draw the vectors. The completed sketch is shown in Figure 7. "Why are the vectors the same length?" (The amount of force on each end of the spring is the same.)

Pull the spring horizontally enough to move the brick. Ask, "Is there more, less, or the same amount of force on the spring as when we first pulled the spring in a horizontal position? How can you be sure?" (Spring stretched more and the brick moved.) "In which direction will the vectors be drawn? Will the vectors be the same length?" (The force of the one pulling will be greater; that force vector will be longer.)

Attach the same spring to a whole brick. Stretch the spring the same distance required to move the piece of brick. Ask, "Is this force more, less, or the same as when we caused the piece of a brick to move?" (The same.) "How do you know?" (The spring was stretched the same amount.) Why does the brick not move?" (The force exerted by the brick on the spring is now greater than the force of the piece of brick.) Draw the spring on the board. Ask one child to draw the vectors showing the forces on the spring. "Why are the vectors now the same length?" (The size of the forces are the same.)

Activity 2

The purpose of this exercise is to show that forces which are not balanced cause an object to move; balanced forces cause an object to be at rest.

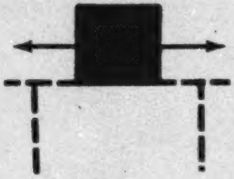


Fig. 8

With a string attached to each end of a block of wood which is lying on a table, ask a child to hold one string taut and another child to hold the other string taut. With both strings taut, ask one child to pull the string hard enough to cause the block to move. Ask, "What caused the block to move?" (A greater force was exerted in the direction in which the block moved.) Draw the block and table on the board. Ask a child to draw a vector showing the direction of this force. Ask, "Is there any other force on the block of wood?" (Yes.) "What is it?" (The taut string held by the other child.) "If we show this force with vectors, showing the amount of force, will the two vectors, be the same length?" (No.) "Which will be longer?" (The one on the end that moved the block.) Ask a child to draw this vector. The completed sketch will appear as shown in Figure 8. Ask the other child to pull the other string until the block moves. Ask a child to draw a force vector showing the direction of the force now. Ask, "What caused the block to move?" (A greater force was exerted on the string in the direction in which the block moved.) "Is there any other force on the block of wood?" (Yes.) "What is it?" (String held taut by the other child.) "In what direction is this force?" Ask a child to draw this vector. If he or she draws it the same length as the first one, ask if the forces are the same. "How can we show one force is greater?"

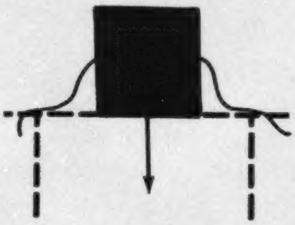


Fig. 9

With the block of wood at rest, but with each child pulling a string taut, ask, "Why is the block not moving? What can we say about the forces?" (The amount of force on both strings is equal but pulling in opposite directions.) Ask the children to drop the strings. Ask, "Are there any forces now on the block of wood?" (Yes.) "Why does the block not float up into the air?" (Pull of the earth.) "What is the direction of the force?" Ask one child to draw this vector. The sketch will appear as shown in Figure 9. "Why does the block of wood not fall to the floor?" (The table pushes up on it and keeps it from falling.) Ask a child to draw this vector. Ask, "What are the forces on the block of wood? In what direction is each?"

Activity 3

"If a seal is balancing a ball on its nose, are there any forces on the ball?" (Yes.) "What are the forces?" Why does the ball not leave the seal's nose and float in the air?" (The pull of the earth holds the ball down.) Sketch something to represent a seal and ball on the board. Ask a child to draw the vector showing the downward force and label it "earth's pull." "Why does the ball not fall to the earth from the earth's pull?" (The seal is pushing it up with its nose.) Ask a child to draw this upward force vector.

Activity 4

"Every day mother squirrel had to climb up to the hole in the hollow tree and carry her baby back to the nest. One day somebody left a board from the ground up to the nest in a diagonal position. Mother squirrel decided to push her baby up the board to the nest." (Place a board to the desk. Sketch the board and desk on the chalk board.) Ask one child to draw a vector representing the direction of the motion. "What would happen if mother squirrel lost her hold of the baby squirrel? What would be the force that would cause it to slide back to the ground?" (Earth's pull.)

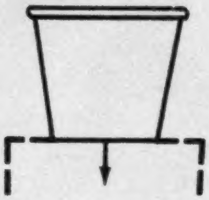


Fig. 10

Appraisal

"The bucket is on a table." On the chalkboard, sketch a bucket on a table. "Is there any force on it? Why does it not float into the air." (Earth's pull.) "Draw the vector showing this force." The sketch will appear as shown in Figure 10. "Is there any other force? What is this force? How do you know?" (The force of the table pushing up on it.) "Why does it not fall to the floor? In what direction is this force? Draw the vector on the board, showing the force." Ask one child to name the forces on the bucket and indicate the vectors showing the direction of the forces (Figure 11). Ask, "Why does the bucket remain still?" (The two forces are of the same amount.)

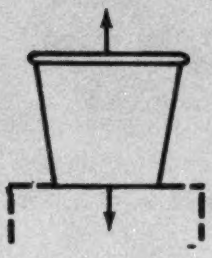


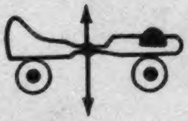
Fig. 11

Table pushing up

Earth pulling down

Appraisal

Give each child a mimeographed sheet with two diagrams.



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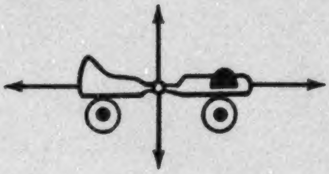


B

Which skate is moving? ______________________
What is the direction? ______________________
What is the force? ______________________

References for the Student

Brandwein, Paul F. *Concepts In Science*, Grades 5 and 6, Harcourt Brace Jovanovich, New York, 1972. o.p.

Smallwood, William L. *Science — Understanding Your Environment*, Fourth Edition, Grade 5, Silver Burdett, Parks Ridge, IL 1972. o.p.

Rockcastle, Vernon N. *Elementary School Science*, Grade 6, Addison-Wesley Publishing Company, Menlo Park, CA 1975.

Film

Forces (14 Min. Color, Film No. 1892) Encyclopaedia Britiannica Films, Inc., 1150 Wilmette Avenue, Wilmette, IL 60091.

Human Resources

The teacher may wish to invite a physics teacher to discuss and demonstrate forces to the students.

Materials

Spring balance, weak spring that stretches easily, two small pieces of brick (each about one-eighth of a brick), one board approximately five inches wide and four feet long, one block of wood approximately 2" x 6" x 10", one roller skate, two yards of twine or light cord, one whole brick, one bucket, and one mimeographed sheet for each student for the appraisal.

UNITS FOR INTERMEDIATE LEVELS

[illegible]

Objectives

At the end of the unit the student should be able to:

- construct a chart of collected weather observations
- state a rule explaining that weather varies according to a pattern
- apply a rule for forecasting weather based on observations and interpretations of a weather pattern

Key Ideas

- Weather takes place in the earth's atmosphere; heat and water produce changes in the atmosphere that cause changes in the weather.
- The earth's atmosphere may be divided into layers based on the characteristics of the atmosphere at different altitudes.
- Radiation from the sun heats the earth, and the earth in turn heats the atmosphere.
- Data pertaining to air temperature, relative humidity, wind speed and wind direction, and atmospheric pressure are used in describing and predicting weather.
- Over the years, improved methods of forecasting weather have been developed.
- Accurate weather forecasting depends on accurate record keeping.

Processes Emphasized in the Unit

Observing, inferring, and predicting

Rationale

From the kind of clothes that they wear and the kinds of activities in which they engage, most children are aware that weather affects much of their lives.

Through planned activities children have an opportunity to observe that weather conditions are affected by temperature, air pressure, air movement, and humidity of the air.

Through continued observation children see that even though these conditions are changing constantly, there is a pattern to the changes. This pattern makes it possible to forecast the weather fairly accurately.

References for the Teacher

Barnard, Stendler and Spock. *Science for Tomorrow's World*, Book 5. New York: The Macmillan Co., 1966. o.p.

MacGregor, E., and D. Pantell. *Miss Pickerell and the Weather Satellite*. New York: McGraw-Hill Book Company, 1971.

Sutcliffe, R. C. *Weather and Climate*. New York: W. W. Norton & Company, Inc., 1966, 206 pp. Good science background for teachers.

Thompson, Philip D., Robert O'Brien, and the Editors of *Life*. *Weather*, Morristown, NJ: Silver Burdett Company, 1965, 200 pp. Picture and text story of the weather.

Initiating the Study

Display pictures related to different kinds of weather, such as pictures of damage caused by a tornado, heavy rainfall, floods, and drought conditions.

Starting with these examples, lead a discussion of local weather and its affect on the activities of the children and their families. Then point out that when a news commentator says, "Coming up next is the weather forecast for today," many people all over the country stay tuned to their radios and television sets to hear what the weather is going to be like. After hearing the forecast, many people make their plans according to it.

Use a series of questions to stimulate interest in keeping weather records; emphasize the importance of keeping accurate records.

- "What was the weather like yesterday?"
- "What is the weather like today?" Answers may include observations of temperature, reference to clouds, wind, and moisture.
- "What will tomorrow's weather be like?"
- "What needs to be done before a weather forecast is made?"
- "What information do forecasters use? How do they get it?" There may be some disagreement at this point. After this discussion, guide the students in organizing their ideas. Proceed to Activity 1.

Activity 1

Organize the class into five or six groups. Permit the groups to decide which weather instruments they will secure or make in order to set up a weather observation station.

Instruments needed:

Thermometer, rain gauge, barometer, wind vane, anemometer, and hygrometer.

Activity 2

Have students list information needed for forecasting weather. Guide them in designing charts for recording their daily weather observations from reading their weather instruments.

Accurate charts should be kept showing daily readings of temperature, wind speed and wind direction, amount of rainfall, barometric pressure, relative humidity, cloud formation, and cloud height. This information may be compared with the Weather Service's daily report for accuracy.

Activity 3

Have the children collect weather reports from television or from the newspaper and use them to watch for approaching fronts. Effects of the fronts, both before and after arrival, can be seen in relation to temperature, barometric pressure, relative humidity, wind direction and wind speed, and cloud conditions.

Discuss the significance of fronts for predicting weather.

Activity 4

Show the class a large chart illustrating how various masses move in from the oceans over the land mass of the United States.

Ask the students to explain how each kind of air mass affects the weather.

Activity 5

Have students use daily weather maps and data from the class weather station to make individual weather forecasts.

"What will be the forecast? Is tomorrow a good day for a picnic? What would you do?"

Check the forecasts against the next day's weather to find out how they compare with the weather and the weatherman's forecast. Find out "why we were wrong if we were wrong in our forecast."

Activity 6

For this activity make a hygrometer that changes color as the humidity of the air changes.

Obtain several spoonfuls of cobalt chloride crystals, a basin, some water, several sheets of white unglazed paper or filter paper, scissors.

Dissolve five grams of the crystals in 50 cc of water. Stir until the crystals have dissolved. Soak a sheet of paper in the solution, lift it out, drain it, and put it aside to dry on a sheet of waxed paper. Soak and dry more sheets of paper until you have used up all of the solution. When the sheets have dried, cut them into interesting shapes and mount them on stiff paper. Observe what happens as the shapes are exposed to the air. Predict how this can be helpful in making forecasts about the weather.

Activity 7

Field Trip — Arrange a field trip to a local weather service office. Most airports have a weather station. Observe the use of various weather instruments and plan a follow-up activity.

Activity 8

Display — Set up a display of the weather instruments made by the class members. Have individual children label their instruments and discuss the kinds of information gathered with each instrument.

Appraisal

Before starting this unit the teacher should collect daily weather maps from the local newspaper for a month.

Have the students use these maps to locate cold air masses. (See page 239, Barnard and others, Book 5.)

After each four or five maps in your collection, insert a blank map. Have the children describe the kinds of weather they would expect on those dates and tell how the weather was predicted. After the discussion, show the maps with the actual weather on them.

Note: Teacher may wish to identify what to put on the above maps.

Bulletin Boards

Suggested captions: "What Will the Weather Be?" or "How Can You Predict the Weather?" "What Causes Weather?" "We Write about Weather," "What Names Would You Give these Clouds?" "How Does Weather Affect Us?"

References for the Student

Books for children:

Bendick, Jeanne. *How to Make a Cloud*. New York: Parents' Magazine Press, 1971. 64 pp. Weather principles.

Berger, Melvin. *The National Weather Service*. New York: The John Day Company, Inc., 1971, 124 pp. Services, techniques, instruments of the Weather Service.

Branley, Franklyn M. *Flash, Crash, Rumble, and Roll*. New York: Thomas Y. Crowell Company, 1964, unpaged. How an electrical charge builds up in a thundercloud until it produces a lightning flash and thunder;

reassuring instructions for safety during a storm.

Buehr, Walter. *Storm Warnings: The Story of Hurricanes and Tornadoes*. New York: William Morrow & Company, Inc., 1972, 64 pp. Description and causes.

Fischler, Lowery, and George Blanc. *Science — A Modern Approach*. New York: Holt, Rinehart and Winston, 1966. o.p.

Gaer, Joseph. *Everybody's Weather*. Philadelphia: Lippincott, 1965.

Jennings, Gary. *The Killer Storms: Hurricanes, Typhoons, and Tornadoes*. Philadelphia: Lippincott, 1970, 207 pp.

Kaufmann, John. *Winds and Weather*. New York: William Morrow & Company, Inc., 1971, 64 pp. Descriptions of kinds of weather.

Keen, Martin L. *Lightning and Thunder*. New York: Simon and Schuster, Inc., 1969, 94 pp. Superstitions, causes, safety rules.

Milgrom, Harry. *Understanding Weather*. New York: Crowell-Collier, 1970, 84 pp.

Navarra, John G., Joseph Zafforoni, and John E. Garone. *Today's Basic Science*. Evanston, Illinois: Harper and Row, 1965.

Pine, Tillie S. *Weather All Around*. New York: McGraw-Hill, 1966.

Rosenfeld, Sam. *A Drop of Water*. Irvington-on-Hudson. New York: Harvey House, 1970, 46 pp.

Ross, Frank. *Storms and Man*. New York: Lothrop, Lee & Shepard, Co., 1971, 192 pp. Storms — their causes, effects, and control.

Rubin, Louis D. *Forecasting the Weather*. New York: Franklin Watts, Inc., 1970, 64 pp. Amateur forecasting. o.p.

Simon, Seymour. *Weather and Climate*. New York: Random House, Inc., 1969, 128 pp. Causes of weather and climate changes.

Spar, Jerome. *The Way of the Weather*. Mankato, Minn.: Creative Educational Society in cooperation with The American Museum of Natural History, 1967, 224 pp. Illustrated with many photographs and drawings; conveys feeling as well as the science of weather.

Stone, A Harris, and Herbert Spiegel. *The Winds of Weather*. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1969, 64 pp. Experiments about winds and their causes.

Thompson, Philip D., Robert O'Brien, and Editors of *Life*. *Weather*. (*Life* Science Library). New York: Time Incorporated, 1968.

Note: The elementary science textbooks in adoption are good references for many of the suggested activities.

Human Resources

Invite a high school or earth science teacher to talk to the class about weather stations, instruments, or other topics interesting to the class.

Invite a meteorologist to visit the class or plan a trip to the nearest meteorological station.

Materials

- pictures of different kinds of weather, introduction
- weather instruments for Activity 1
- various charts for Activity 2
- weather reports from television and/or newspapers for Activity 3
- large chart showing how various air masses move in from the oceans over the land mass of the United States for Activity 4
- an account of "the next day's weather" and "the weather forecast" for Activity 5
- cobalt chloride crystals, water, filter paper, glass jars, waxed paper, scissors for Activity 6
- daily weather maps from the local newspaper for a month preceding the Appraisal Activity
- blank maps of the United States for the Appraisal Activity

- a shiny, empty tin can, pieces of cracked ice, thermometer, warm water for finding the dew point for predicting rain for Activity 2
- a kettle for boiling water, water, a saucepan, ice cubes or very cold water, electric hotplate for "homemade" air masses in Activity 4

Materials for making weather station instruments

Rain gauge:	one glass jar with straight sides and a flat bottom, and one longer, narrower jar
Barometer:	one clean, dry milk bottle, warm water, rubber balloon, rubber bands, paper drinking straw, glue
Barometer:	one large bottle, rubber stopper with a hole in it, and a glass tube at least six inches longer than the bottle, food coloring, white card
Barometer:	a medicine bottle with a dropper cap, white paper for a scale, food coloring, water
Wind Vane:	a metal coat hanger, a medicine dropper, milk carton, stapler, pliers, candle for melting tip of medicine dropper, scissors
Anemometer:	a metal coat hanger, two strips of thin wood, medicine dropper, pointed paper cups (4), block of wood on which to attach the completed anemometer
Hygrometer:	the materials in Activity 6 result in a hygrometer that changes color as the humidity changes.

Note: In addition to the references listed, the elementary science series in adoption will have directions for building additional simple weather station instruments.

CLASSIFICATION OF LIVING THINGS

Objectives

At the end of the unit, the student should be able to

- distinguish between living and nonliving things and state the basis of classification
- identify similarities in living things
- distinguish between plants and animals and state the basis of classification

Key Ideas

- Man is constantly classifying things in many ways.
- Everything may be classified as either living or nonliving.
- As far as living things are concerned, Linnaeus' system of classification is still used today.
- Plants and animals have characteristics which distinguish them from each other.

Processes Emphasized in the Unit

Observing, classifying

Rationale

Classification is an everyday occurrence for all of us. Ideas are sifted through our mind and a decision is made about their importance. We call upon past experiences to help us in our classifications. Animals have also developed systems of classification. For example, a honeybee is able to tell whether a new supply of nectar is near or distant and inform the other bees of the direction and distance from the hive. In science, a standard system of classification has been developed and agreed upon. Though it has been modified many times, the Swedish scientist Karl Linnaeus devised his system in the eighteenth century.

Linnaeus' classification of living things was based primarily on structure. More recent systems also include function. Changes have occurred as knowledge of environment has changed.

The student should realize that careful observation is the basis for accurate classification. Then the student should group observations based on shared characteristics. This decision may be very arbitrary, since it is usually based on the convenience and utility of the classification scheme.

The process of classification is not new to students, as they do much classifying without realizing it.

References for the Teacher

Buchsbaum, Ralph. *Animals Without Backbones*. 2nd ed. Chicago: University of Chicago Press, 1972. Good material on classification of invertebrates; very readable.

Carr, Rachael. *Safari to Ngorongoro*. New York: Coward, McCann & Geoghegan, Inc., 1976.

Fitzpatrick, Frederick L., Thomas D. Bain, and Harold E. Teter. *Living Things*. New York: Holt, Rinehart and Winston, 1970. A short but meaningful discussion with pictures on classification of living things.

Hegner, Robert. *Parade of the Animal Kingdom*. New York: The Macmillan Co., 1967. This book although not new, is still used as a basic reference by students of zoology everywhere; very easy to read.

Lauber, Patricia. *Earthworms: Underground Farmers*. Champaign, IL: Garrard Publishing Company, 1976. (Grades 3-6)

Lewin, Ted. *World Within A World: Everglades*: New York: Dodd, Mead & Company, 1976. (Grades 5 and up)

Polseno, Jo. *Secrets of a Cypress Swamp: The Natural History of Okefenokee*. New Jersey: Golden Press/Education Division, Western Publishing Company, Inc., 1976. (Grade 4 and up)

Selsam, Millicent E., and Joyce Hunt. *A First Look at Frogs, Toads and Salamanders*. New York: Walker & Company, 1976. (Grades K-3)

Simon, Seymour. *Exploring With A Microscope*. New York: Random House, 1969. Includes rules for using a simple microscope and many simple experiments. Contains excellent illustrations.

Weisz, Paul B. *Science of Biology*. 4th ed. New York: McGraw-Hill, 1971. Has a very thorough and interesting section on classification.

Initiating the Study

Gather an assortment of objects. (Suggestions: bottle, wooden pencil, mechanical pencil, pen, plastic tumbler, glass tumbler, paper cup, piece of chalk, glove, green plant, cut flower, potato, sneaker, onion, book, nail, screw, piece of wood.) Suggest to the class that they arrange these objects by sorting them into groups of similar objects. For a large class, duplicate sets may be desirable. Compare the results in a class discussion which should reveal the idea that classification may be based on different characteristics. Point out to the class that even professional taxonomists (scientists who classify plants and animals) often disagree about which characteristics are the most important and how to classify some organisms.

Activity 1

Have several examples of living and nonliving things, such as growing plants; artificial plants; a toy turtle; a live turtle; an aquarium with fish, snails, sand, rocks, etc. available for the students to observe. Ask how they can tell whether something is alive. They may say that living things move about. Further discussion may refine this idea. Automobiles and clouds move, but they are not alive; a plant does not move from place to place, but it is alive. Someone else may suggest that a child, a plant, or a bird can get bigger, but so can a balloon, a snowball, or a sugar cube, yet they are not living things. At this point, an interesting demonstration with a sugar cube is to have a group or groups of children stir sugar into hot water until no more will dissolve. Carefully pour off the water from any undissolved sugar. Let the sugar solution cool slowly. Before it has cooled completely, drop a piece of a sugar cube into the solution. Observe the crystals forming and collecting on the cube. Point out that the cube got larger. Now have the students describe the characteristics that they think distinguish living things from nonliving things.

Activity 2

Have a live animal, a live plant, and a nonliving object such as a rock in the room.

Ask, "Which of these can move from place to place by itself—goldfish, frog, geranium, house, tree, rock, or snail? Do trees and other plants move?" (Not from place to place as animals do.) "Does this mean that plants do not move at all?" Many have probably observed a plant with leaves turned toward the sunlight that when first placed in the window had its leaves turned away from the light. Others will mention growth as an illustration of movement. Some may have seen plants, such as the Venus flytrap, which have special structures that do move.)

Ask, "What needs do plants and animals have that rocks do not have?" (Air, food, and water.) A brief discussion should be conducted about the requirements of living things and the ability of nonliving things to do without these requirements.

Ask, "What are some things in the room that can grow? What are some things in the room that cannot grow?" (In this discussion, the students should be led to mention that a small plant or animal will grow to be a large plant or animal, but a rock, for example, cannot grow.) Some may mention that a nonliving object such as a crystal or an icicle may "grow," but the way it grows is different from the way a living thing grows. A living thing grows as its food is changed into living material and is added to its body from the inside. A nonliving thing "grows" by external additions.

Suddenly toss a ball to some person in the group. Ask, "Did (name) move? What caused the movement?" (Reaction) "Do all living things react or respond to outside influences?" (Yes)

"Has a pet of yours had babies? Have you planted some seeds in your garden or yard? Did the young animals or plants resemble older animals or plants?" (During this discussion, try to elicit the term "reproduce.") "Do nonliving things reproduce? Why is reproduction necessary for living things and not for nonliving things?" (Because living things die and reproduction is necessary for life to continue.) "Do you know of any animals now extinct?" (They will probably mention the dodo bird among others.) "What are some animals now nearly extinct?" (Whooping crane and buffalo.)

Have students in small groups list characteristics which they can use for adequately distinguishing between living and nonliving things. Be sure that their list includes the ideas of: growth, movement, reaction, and reproduction. Have the students demonstrate the adequacy of their system by applying it to an animal, plant, and rock in the room.

Activity 3

Ask, "If you divide all living things into two groups, what would you name the groups?" (Plants and animals. Note: other answers, such as green and not green, may be given, but keep questioning.) Suggest that they make a list of ways that plants and animals are alike. (They may say, "They respond to their surroundings; they grow and develop; they produce offspring like themselves; both consist of protoplasm and cells.") "How do they differ?" (Answers might include mention of the manner in which they obtain their food — plants manufacture their own by photosynthesis and animals eat plants or other animals which have eaten plants — and most animals are able to move around in their environment while most plants cannot. Another difference can be discovered by students through use of microscopes to examine the difference in plant and animal cells — the plant cells have cell walls, and animal cells do not. Slides may be easily prepared from plant tissue such as scrapings from an onion and from animal tissue such as scrapings from the inside of a student's cheek.)

Appraisal

Give each student a copy of the Classification Key, (p. 43) and instruct him or her to locate the appropriate place for each item listed at the top. Write the name of this item on the line provided.

Have students describe their reasoning privately to the teacher as they complete the appraisal sheet.

References for the Student

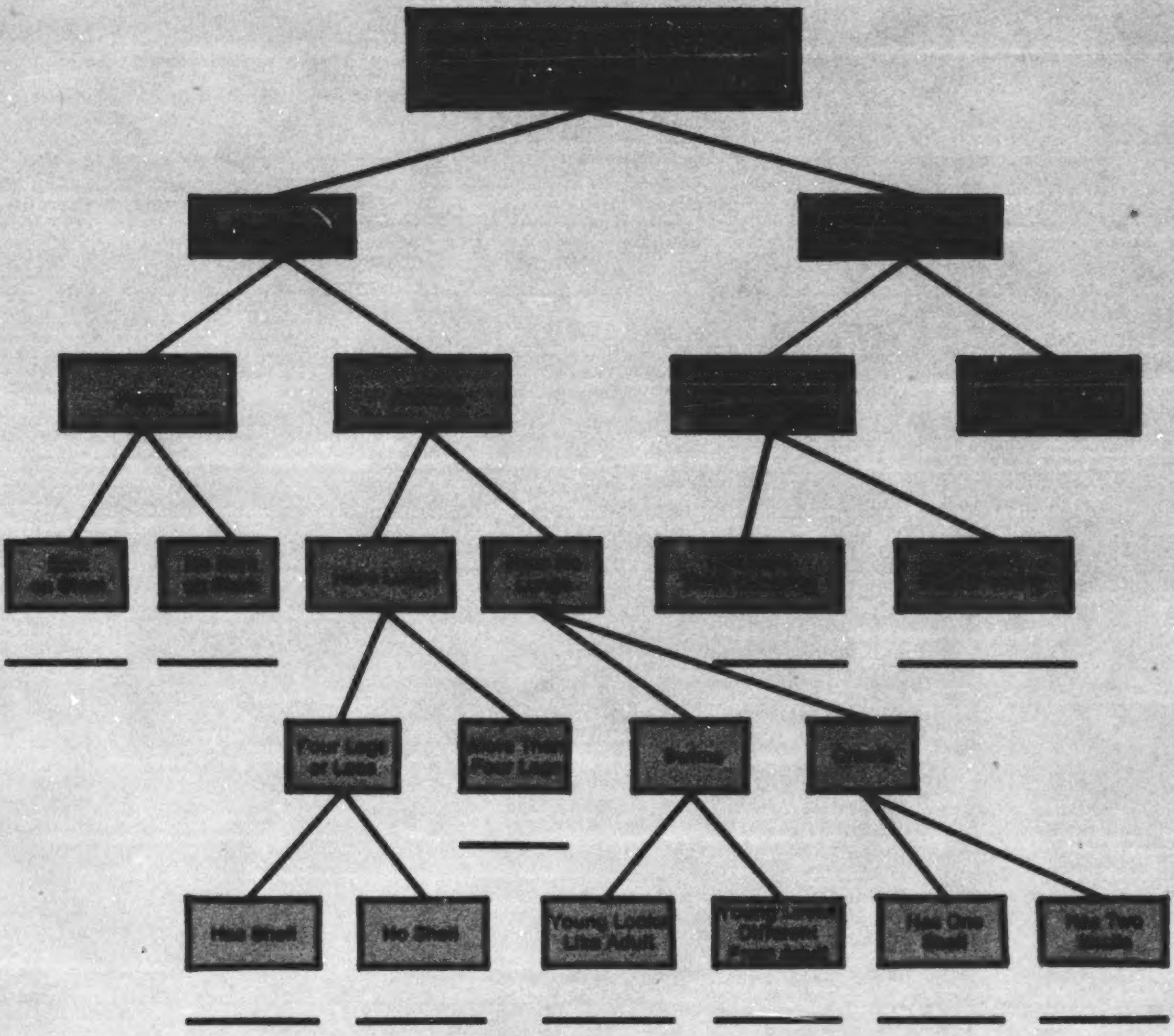
Films

Living Things are Everyhwhere. Encyclopaedia Britannica Films, Inc., Wilmette, Illinois.

What's Alive. Film Associates of California, Los Angeles.

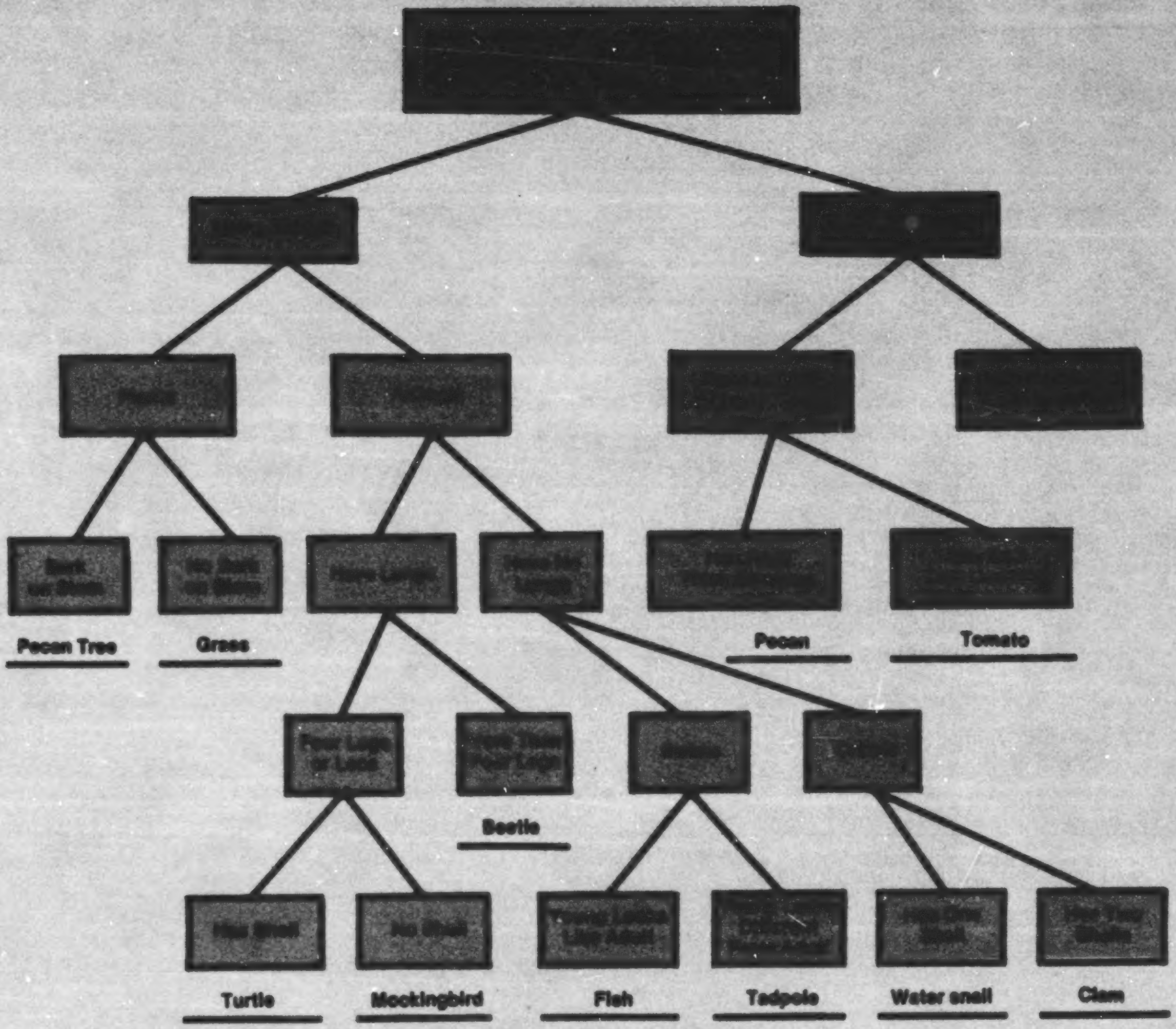
Materials

Assortment of objects (see Initiating the Study)
Examples of living (at least one plant and one animal) and nonliving things
Sugar and sugar cube
Hot water
Ball
Microscopes, slides, cover slides, and onion (optional)
Ditto sheet of classification key for each student
Living and nonliving things in Activity 1


Four Legs or Less
More Than Four Legs
Swims
Crawls
Has Shell
No Shell
Young Looks Like Adult
Different
Has One Shell
Has Two Shells

CLASSIFICATION KEY

48


Plants
Animals
Bark on Stem
No Bark on Stem
Have Legs
Have No Legs
Pecan Tree
Grass
Pecan
Tomato
Four Legs or Less
More Than Four Legs
Scales
Beetle
Has Shell
No Shell
Young Looks Like Adult
Has One Shell
Has Two Shells
Turtle
Mockingbird
Fish
Tadpole
Water snail
Clam

CLASSIFICATION KEY
ANSWERS

[redacted]

(This unit could be effectively used simultaneously with a social studies depth study of the topic, "Supply, Distribution, Uses, and Conservation of Water." The two studies would complement each other. In addition, such an approach would tend to demonstrate the social significance of science and the interrelatedness of physical and social sciences.)

Objectives

At the end of the unit, the student should be able to:

- identify some of the characteristics of water
- demonstrate that although water behaves peculiarly as liquid, it does follow established laws and its behavior is predictable
- identify ways that water's peculiar behavior works to the advantage of humans
- construct tests to isolate the various characteristics of water

Key Ideas

- Water is a solvent. Almost every chemical dissolves in water.
- Surface tension of water is tremendous. It is capable of supporting comparatively heavy weights.
- Water tends to travel downward, following the rules of gravitational forces, but it also has a unique quality in that it travels upwards. This unique behavior of water is referred to as "capillary action."
- When frozen, water behaves atypically for liquids in that it expands rather than contracts.
- Molecules of hydrogen and oxygen, which make up water, attract one another and tend to hold together in a bond known as the "hydrogen bond."
- Water exists in three forms in nature: liquid, solid, and gaseous.
- Although water behaves unusually as a liquid, it follows natural laws governing it.
- Water's uniqueness tends to work to human's advantage and welfare.
- Water is the only natural substance that is naturally present on the earth simultaneously and abundantly in three forms.
- Water has great capacity for absorbing other substances but it can be freed of these substances through comparatively simple means.
- Water in pure form is rare because of its nature to serve as a solvent.

Processes Emphasized in the Unit

Measurement, use of numbers, classifying, and predicting

Rationale

The story of water is in many ways the study of life itself. It is a major part of every substance of every living thing on earth. People are dependent on it for life, for power, for transportation, and for satisfying the thirst of their plants and animals.

Water is the most common substance of all, yet it is the least understood. Water is nonconforming. Its very nonconformity benefits humans in many ways. As a substance, it is colorless, odorless, and tasteless. It contradicts the general laws governing freezing and boiling of liquids; yet, it follows its own rules faithfully, providing predictable patterns.

Water has many qualities. It can dissolve many substances, and it can be freed from them by rather simple filtering processes which exist in nature. Water tends to purify itself as it makes its constant cycles about the earth. Water is an agent for construction and destruction, a dynamic force.

The supply of water remains constant. The earth's original supply is still around. Water is constantly in motion. It exists simultaneously in the earth in three forms, and each form has a contribution for human beings. Natural laws tend to keep water usable by man, by other animals, and by plants. Water is a central force in the ecology of life.

The study of water through careful observation should impress children. It has many observable qualities which may be noted. Close observation will lead one to the conclusion that scientists have few of the real answers in regard to it. Its close relation to life itself makes it a prime subject for the inquiring minds of children.

References for the Teacher

Bendick, Jeanne. *Exploring An Ocean Tide Pool*. Champaign, IL: Garrard Publishing Company, 1976. (Grades 3 and up)

Farb, Peter, and the Editors of *Life*. *Ecology* (*Life* Nature Library). New York: Time, Incorporated, 1970. One of the *Life* Nature Library. Deals with the relationship between living things and the sources of life; namely, water, air, and food.

Hare, F. K. *The Restless Atmosphere*. New York: Harper and Row, Publishers, 1966. Presents a view of water as a gaseous vapor. o.p.

Halacy, D. S. *Now or Never: The Fight against Pollution*. New York: Four Winds Press, 1971, 203 pp. General, excellent treatment.

Gega, Peter C. *Science in Elementary Education*. 2nd ed. New York: John Wiley and Sons, Inc., 1970. Presents basic information and makes practical suggestions for using it with children.

Leopold, Luna B., Kenneth S. Davis, and the Editors of *Life*. *Water* (*Life* Science Library). New York: Time Incorporated, 1970. Concepts and generalizations are very carefully spelled out for the teacher in this volume. The explanations are clear, the illustrations are striking. Pictures illustrate the tests which are recommended in the book. Might be used effectively by students seeking additional information.

Navarra, John Gabriel, Joseph Zafforoni, and John E. Garone. *Today's Basic Science: The Molecule and the Biosphere*. Evanston, Illinois: Harper and Row, Publishers, 1965. Written especially for students; concise and to the point. Good illustrations. Contains brief biographical studies of scientists.

Nelson, Leslie W., and George C. Lorbeer. *Science Activities*. 5th ed. Dubuque, Iowa: William C. Brown Company, Publishers, 1972. A handy source for a teacher who is shy when it comes to science content and experimentation. Also an excellent source of ideas in science and how these ideas can be tested and evaluated.

Wiesenthal, Eleanor and Ted Wiesenthal. *Let's Find Out About Rivers*. New York: Franklin Watts, 1971.

Williams, Jerome. *Oceanography*. New York: Franklin Watts, 1972.

Learning Experiences

By the time children are nine, 10, 11, and 12, they develop fairly sophisticated sets of skills for observing, measuring, using numbers, using space and time relationships, and using the other processes of science. In addition, they have been accustomed to the use of discussion techniques and questions to guide their thinking and to probe for answers which reach beyond the superficial. Self-study time has taken them into the instructional media collections using the vertical file; films, film strips, and single concepts films; tapes of discussions by human resources; books; and interviews.

Participation is a normal part of learning. In the following, much emphasis is placed on pupil action. The teacher's role is one of providing the opportunities, stimulating, providing enthusiasm, rewarding, guiding, questioning, and seeking inferences and generalizations which stand the test of close scrutiny. Some students will require a slow pace; others will need the added stimulation of individual experimentation and study.

Ask, "Water is everywhere — all around us — yet, what is it? How does it behave? What do we know about it?"

Activity 1

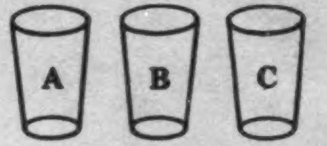
Materials needed: 12 clear water glasses, white vinegar, bottled water, and 7-Up.

Place three small water glasses on each of four different tables around the classroom. The glasses are labeled "A," "B," "C." Glasses marked "A" contain water (non-chlorinated, preferably), glasses marked "B" contain white vinegar, and glasses marked "C" contain 7-Up. Ask the children to describe, by observation, what they see.

"Are all glasses filled with a liquid?" (Yes.) "Are the liquids clear?" (Yes.) "Do they look alike?" (Two do, one has a different appearance.) "How is it different?" (One, Glass "C," contains bubbles. These bubbles rise to the top of the liquid on occasions. The glasses appear to contain liquids which are colorless.)

"What is a liquid?" (Something that pours, takes on the shape of its container, lacks definite shape in itself.)

Now, ask children to check the glasses more closely. Perhaps, they can apply the sense of smell to test their observations. "Do the contents of the glasses have an odor?" (Two do, one does not.) "Which one does not?" (Glass "A.") "What is the odor of 'B'?" (Acid, strong, sour.) "What is the odor of 'C'?" (Difficult to describe. Bubbles tickle the nose. It is almost odorless.) Observations should be checked a number of times to make sure conclusions were not the product of an accident or based on chance.



Ask the children to taste the liquids after reminding them that tasting is dangerous unless one is advised on good authority of the safety of the substance being tasted. "Does Glass 'A' have any taste?" (No. It seems to be water.) This is an inference. "Does Glass 'B' have a taste?" (Decidedly. It is sour. It definitely does not taste like water.) Some children may say that the contents is vinegar, an inference, of course. "What about Glass 'C'?" (Glass "C" contains something which tastes sweet. It's 7-Up.)

"Did you notice that all three share two common features — each is a liquid and each is clear?" Someone will mention that bubbles appeared in one and not the others. The three liquids do share these common traits, however.

Since at this level the chemical composition cannot be proved, it may be concluded in the discussion that:

- Three different liquids were in the three glasses.

- One was tasteless, two had a definite taste; one had no odor, two did.

- Water, the subject of the investigation, was in Glass "A." It is clear, colorless, odorless, and tasteless.

Activity 2

Materials needed: six water glasses, six double-edge razor blades or six strips of metal foil, water, and six medicine droppers.

Divide children into four to six groups, with each group at a table. On each table place a double-edge razor blade and a large-mouth glass.

Fill each glass with water to three-fourths of capacity. Then ask a representative of each group to lift the razor blade carefully between the thumb and forefinger and place it flat side down, on the surface of the water. It should float. If it doesn't, coat the surface of the blade with some sort of oil.

Ask, "What makes the metal float? Do you notice anything special about the water around the edges of the blades?" (Water has an elastic surface upon which many objects can float. This property of water is called "surface tension.")

"When the blade is punched or pushed, the blade sinks. Why?" (The bond which keeps the molecules together is broken and the weight of the metal is greater than the water it displaces, so it sinks.)

"Do you know of an insect which can 'walk on the surface of the water'?" (There is a water bug which walks on the surface of the water.) See if you can help the children find the name of this insect.

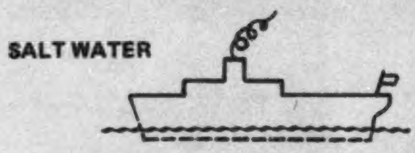
Take up water in a medicine dropper. Hold it high above the glass container. As you squeeze the rubber bulb, the water that is released forms round balls or spheres. "If you could photograph the drop as it falls, you would note that it is round or spherical in shape. Why is that?" (Here again surface tension forms a sort of "skin" on the outside of a drop of water keeping it together. If the drop falls far enough, it will meet resistance in the air and tend to flatten.)

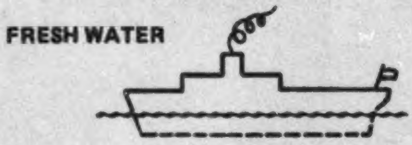
Each water molecule is made up of two atoms of hydrogen and one atom of oxygen. Chemists write the symbols for this combination as: H_2O or HOH.

Activity 3

Materials needed: 12 water glasses, six eggs, salt, and teaspoon.

Fill the glasses with water to about three-fourths of their capacity. Arrange six pairs of glasses around the classroom so that small groups can work with each pair. In one glass in each pair, dissolve two teaspoons of salt. Give each experimental team an egg. Place the egg in each container and observe the results.





"Did the salt change the appearance of the water?" (Yes. The water became clouded and not so clear.) "Did the egg float in either container?" (Yes, in the salt solution.) "What did the salt do to the water to change it? Why did the egg float in the salt water but sink in the clear water?" (The salt did something to the water so it could support a heavier weight. It made it more dense.) If both glasses of water were weighed, the one with the salt added would be a little heavier. "Does this principle apply to ocean and fresh water navigation? Should ocean-going ships consider their loads as they enter the fresh waters of the St. Lawrence and Great Lakes?" (Ships float higher in salt water than in fresh. Ships will sink deeper in fresh waters of rivers and require deeper harbor facilities.) "Does the density of water ever change?"

Activity 4

Materials needed: container of water, twigs, leaves, cork, small square of paper, piece of glass, aluminum thermal bottle cup, and a small medicine bottle.

"We have observed that relatively heavy, flat objects can float on the surface of water because of surface tension. Why do some objects float while others do not?" Place a large container of water on a table and gather children around. Invite a child to place items collected for the test in the water. "Which float?" List those which float and those which do not. Those which float: twig, leaves (for a time), cork, medicine bottle with no water in it, cup when it is placed upright.

"Do you notice anything unusual about the leaves?" (They float for a time and then sink when water is absorbed.) "We say the leaves become water logged."

Unscrew the top of the medicine bottle. Fill partially with water. "Now, does the bottle float?" (It will continue to float until almost filled with water.) "What makes things float?" (Objects float in water if they push aside—displace—enough water to equal their own weight. Some objects sink after they become water logged-saturated with water-because the light air is replaced by heavier water.) Question to be considered: "How does the submarine float and submerge at the will of the captain? How is this possible?"

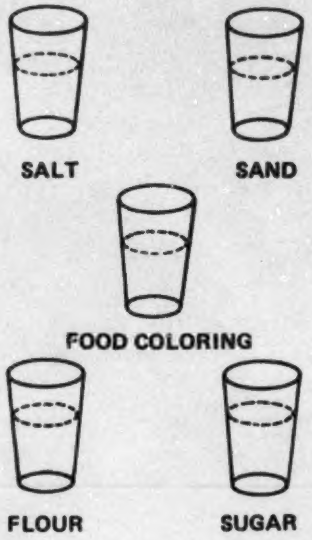
Activity 5

Materials needed: 15 water glasses, food coloring, three teaspoons sugar, three teaspoons salt, three teaspoons floor, three teaspoons sand, and water.

"Water is said to be a wonderful solvent, a material which will dissolve another. Will water dissolve all substances? Observe what happens when these mixtures are applied to water."

On each of three tables about the room, place a set of five water glasses. Fill each glass with water, being careful to fill the glasses to the same level, about three-fourths of capacity. Now for each set of five glasses: add two drops of food coloring to Glass One, one teaspoon of sugar to Glass Two, one teaspoon of salt to Glass Three, one teaspoon of flour to Glass Four, and one teaspoon of sand to Glass Five.

"Did all substances dissolve? Did all substances become a part of the water or did they float or sink?" (No. Not all of the substances dissolved. Some did. The sand and flour sank to the bottom of the containers. The salt, sugar, and coloring dissolved in the water.)



"Did the added substances change the color of the water?" (The food coloring did change the color of the water. The salt solution caused the water to appear cloudy. Dirt from the sand discolored the water temporarily, but the sediment soon settled to the bottom of the containers.)

Some substances dissolve in water; some do not. Some additional questions to explore: "What do we mean when we say, something is water soluble? What is meant by solvent? Since many things dissolve in water, how does this affect our lives?" (Discuss, for example, the effect of water on soils. Water dissolves salts and minerals and washes them from soil. Discuss water mixtures as foods. Lemon juice and sugar added to water makes a pleasing drink. Discuss the effects of water on soft rock particles and on salts in the earth. Discuss other forms of erosion.

Activity 6

Materials needed: two large glasses, two ice cubes, water, alcohol, and a spoon.

In this activity, the teacher can answer only "yes" or "no" questions raised by the students, thus leading children to discover their own answers. This needs to be explained to the class before beginning the activity.

The teacher places two glasses before the class. Unknown to the children, one glass contains alcohol and the other contains water. An ice cube is placed in each glass. Be sure the children do not have a chance to smell of the contents of the glasses before the end of the activity.

"What happens to the ice cubes?" (One floats and the other sinks slowly to the bottom.) The children will discover that the density of fluids is related to their power to float objects.

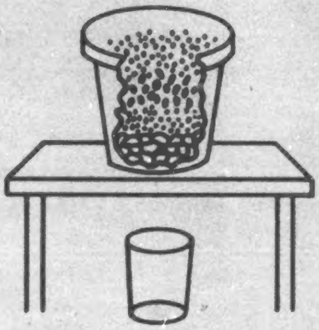
Some sample questions that the children might ask are: "Are both glasses filled with water?" (No) "Are both cubes the same thing?" (Yes) "Are both cubes glass?" (No) "Are both cubes ice?" (Yes) "Are all four things the same temperature?" (No) "Are the two liquids the same temperature?" (Yes; they should be room temperature.) "Is one liquid heavier or lighter than the other?" (Yes) "Is the liquid lighter than the cube in both glasses?" (No) "Is the liquid in the glass with the floating cube heavier than the other liquid?" (Yes) "Is this liquid more dense (denser) than the other?" (Yes)

Students may suggest other activities to verify statements or questions from this activity. This would be a good time to let them try their hypotheses.

Activity 7

Materials needed: eight-inch flower pot, pint of fine sand, one-half pound fine charcoal, food coloring, small stones, two water glasses, and water.

Group children around a classroom table. Place an empty flower pot on a stand on the table. Center a water glass under the hole in the bottom of the pot. Place stones in the bottom of the pot to keep other materials from falling through into the glass container below.



Then place a layer of fine sand and a layer of ground charcoal and another layer of fine sand so that the pot is almost filled. Drop food coloring into a second glass of water. Slowly pour the colored water into the flower pot containing the sand and charcoal. "Note the color of the water that drips through the filter. What color is it? Do you think the coloring was filtered out? What happened to the coloring? Impurities, represented by coloring in this case, cling to the grains of sand and charcoal and the water is freed of many of them."

Water can be made suitable for human use through filtration.

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"Is this characteristic of water useful to people? The earth has a system of built-in fibers which operate to remove some materials from water. Can you think of ways people use filters? (Sewer treatment, removal of poisons from factory wastes, and the cleaning of mud and soils from the city's water system.)

Have students design and carry out an activity to find the answer to the following question: "When water evaporates does it take impurities with it?"

Activity 8

Materials needed: block of wood, piece of glass, block of clay, block of paraffin, pan, water, six glasses, magnifying glass, piece of cloth (cotton).

Place various substances -- wood, glass, clay, paraffin — in water. Note whether or not water clings to the material it touches. Ask the class to which of the materials the water adheres. "Does water cling to wood?" (Yes) "Clay?" (Yes) "Glass?" (Yes) "What about the paraffin?" (No) "Why do you think the water might not stick to the wax surface?"

Water has ability to move uphill under certain conditions. Use a magnifying glass to see the water edges in glasses. "Does the water tend to move up the walls of the glass?" (Yes. It rises around the glass wall.)

Place a piece of cotton cloth partly in the water and mostly on the wall of the glasses. "Does the water rise in the fibers of the cloth?" (It does.) We are not sure why. We know it tends to stick to some surfaces and not others. The way the molecule is arranged seems to be a cause for this behavior. "Do you know of ways our ancestors made use of this principle in their homes?"

Question for further study and thought: "Why does water rise in the stem of plants?"

Activity 9

Materials needed: block of dry ice, knife or screw driver, medicine dropper, spoon, water, metal tray or pan, hot plate, heat-treated thermometer.

"We have observed that water commonly is found in a liquid form. It flows and it takes the shape of its container. Does it exist in other forms?"

Place a block of dry ice or frozen carbon dioxide (chemical symbol — CO_2) in a metal pan in the center of a table where children can observe it. HANDLE WITH TONGS OR THICK GLOVES ONLY! Dig a hole or cut into the center of the dry ice. The hole should be large enough to hold a small quantity of water.

Take a spoon of water and pour it into the hole in the dry ice. "What happened to it? Does the dry ice evaporate? Does it 'melt' the dry ice? What did happen?" (The water froze.) Actually, dry ice is much colder than ordinary ice and it freezes water which comes in contact with it. Sometimes, dry ice reaches a temperature of -80 °C.

Heat a small amount of water in an open pan. "What happens to the water as it boils? What is happening to the water? Where does it go? Can you see the water when it leaves its form as water?" (Water is vaporized or turned into steam. The steam rises and disappears into the air as a gas.)

Place a heat-treated thermometer in the pan of water which is being heated. "At what temperature does the water boil? As the boiling takes place, does the water continue to get hotter?" (Water boils at 212 °F or 100 °C at sea level.) Place a thermometer in a container of water and place them in the freezer compartment of the cafeteria refrigerator. "At what temperature does the water freeze?" (At 32 °F.)

"Then, what is the temperature range of liquid water?" (The range is between 32°F and 212°F.) On a Celsius thermometer the range would be expressed as between 0°C and 100°C. These measurements are taken at approximate sea level. Some child may wish to find out the relationship between the Fahrenheit and the Celsius thermometers. Maybe this student could explain the finding to the class.

"Is water typical of other liquids in its boiling and freezing points?" This is a very interesting question that may be explored with children. Here is where a resource person — perhaps a high school physics teacher accompanied by a team of high school "scientists" — can be a demonstrator for the class.

Some students may be interested in doing conversions from one scale to another. It is easiest to do from prepared tables but can be done from the following formula. To change from Fahrenheit (F) to Celsius (C), use $^\circ C = \frac{(^\circ F - 32^\circ)}{1.8}$.

To change from Celsius (C) to Fahrenheit (F), use $^\circ F = (^\circ C \times 1.8) + 32^\circ$.

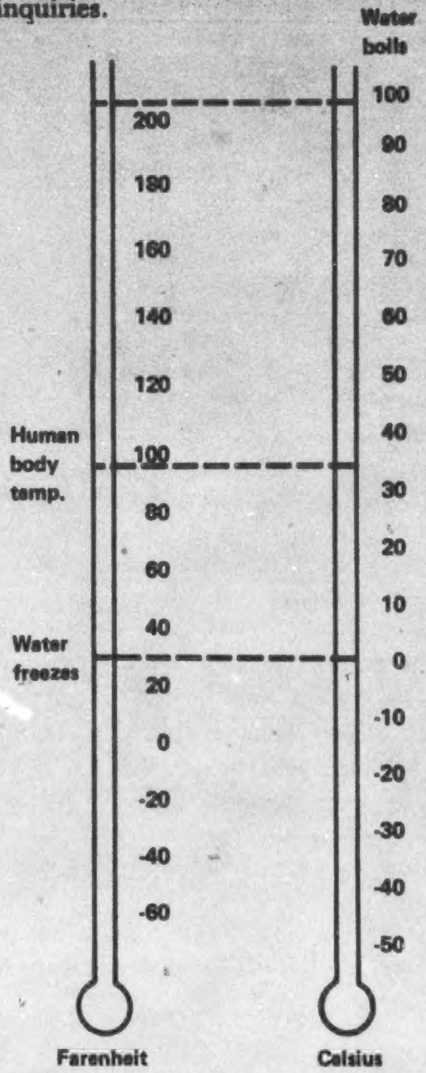
Activity 10

Materials needed: paper milk cartons, water, and freezer unit.

If a physics teacher gives a demonstration as suggested in Activity 9, the class will find that water behaves atypically as a liquid and that this behavior is in the interest of humans.

Have the students fill the milk cartons (half pint or any desired size) full with water and reclose. Staple the top to prevent any accidental opening in the freezer. Allow to remain overnight to completely freeze.

As it freezes, water is also a strange performer. It again disregards the laws under which other liquids perform and again this is to human's benefit. "What would happen on the earth if water did continue to contract as it froze? Suppose that it boiled at the temperatures of other liquids, what would this do to cooking?" Ask the students to think about these questions and their answers. Maybe they will suggest additional tests and inquiries.



We have said that water is a strange performer when it freezes. Just what happens? Most substances contract when cold; expand when warm and hot. Does water follow this pattern? Does it follow the pattern all through the process of freezing? You have checked the water in the freezer a number of times. You noted that first ice crystals began to form in the water and the temperature dropped as the heat in the water was removed. If you had a scientific laboratory where you could observe the water in your container, it would indeed contract until the temperature reached around 39°F. At that point it begins to expand and become lighter in weight.

Expansion of ice in freezing creates problems. If you left the water in the freezer long enough and the water hardened into ice, you noted that something happened to the carton. What? Yes, the container burst. Has this happened to you before? Did you ever place a drink bottle in the freezer and forget it? If you did, you know what a mess it made.

Other Activities: Many Unsolved Problems

"There are still many questions that we have not attempted to answer as we looked at the characteristics of water. There are some questions which still baffle humans. We simply do not understand water as much as we would like. There are many unanswered questions.

"But there are still questions which you may help discover for yourself. What causes water to be 'hard'? Or, putting it another way, why do we sometimes have to use water softeners? How is salt water made fresh? Is our drinking water ever really pure? Why is it difficult to provide pure water?"

Appraisal

1. Divide the class into groups and give each group a glass, three-fourths full, of a clear liquid. Have the materials used earlier to perform the activities available on a table.

   Ask each group to decide on a best way to determine if the liquid in the glass is water or not. Have the children discuss their reasons for selecting that characteristic as the test.

2. Put two glasses of liquids marked "A" and "B" and several balls of clay on a table at the front of the classroom.

   Ask children how they would determine which liquid is more dense if all they had to use was a ball of clay. Have the children discuss their reasons for selecting that way of testing density.

3. Ask the children to describe a way of getting fresh water for drinking from ocean water.

References for the Student

Buehr, Walter. *Water: Our Most Vital Need.* New York: W. W. Norton & Company, Inc., 1967, 102 pp. o.p. Sources, needs, cycle, and problems.

Cunningham, Floyd F. *1001 Questions Answered about Water Resources.* New York: Dodd, Mead & Company, Inc., 1967, 258 pp. information organized around answers to questions.

Farb, Peter, *Ecology* (*Life* Nature Library). New York: Time Incorporated, 1970.

Hoffman, Melita. *A Trip to the Pond.* Garden City, N.Y.: Doubleday & Company, Inc., 1966, 61 pp. o.p. Helps young explorers discover the variety of life in a small area of a pond. Includes a useful guide to capturing and caring for some pond animals.

Navarra, John G., Joseph Zafforoni, and John E. Garone. *Today's Basic Science: The Molecule and the Biosphere.* Evanston, Illinois: Harper and Row Publishers, 1965.

Sherman, Diane. *You and the Oceans.* Chicago, IL: Children's Press, 1965, 63 pp. o.p. Introduction to oceanography.

Simon, Seymour. *Science at Work.* New York: Franklin Watts, Inc., 1972, 87 pp. o.p. Experiments and experiences in oceanography.

Stephens, William M. *Science Beneath the Sea.* New York: G. P. Putnam's Sons, 1966, 223 pp. o.p. The story of oceanography.

Tangborn, Wendel U. *Glaciers.* New York: Crowell-Collier and Macmillan, Inc., 1965, unpaged. What glaciers are; how they are formed; and why they move. Easy.

Thompson, Philip D., Robert O'Brien, and Editors of *Life*. *Weather* (*Life* Science Library). New York: Time Incorporated, 1965.

Human Resources

One excellent source of information to the teacher is the human resource. Resource people add interest and help children gain a respect for knowledge and scientific method among scientists. Here are some sources which might be considered:

Pharmacist
High school science teacher
Laboratory technician
Industrial chemist
Oceanographer
Chemist at water works
Physician
Water engineer
Agricultural specialist
College professor of science
High school science students

Scientists

The biographies of persons who have made significant discoveries that have added to knowledge of water can motivate further study by the student.

> John Muier, conservationist; Gifford Pinchot, conservationist; Joseph Black, chemist; Henry Cavendish, physicist-chemist; Edmund Halley, astronomer; Archimedes, Greek geometer; Lewis Mumford, historian; Dennis Papin, physicist; Edmund Forbes, oceanographer; Sir John Murray, oceanographer; Thales, Greek astronomer; John Dalton, chemist; James Watt, inventor.

Materials

Although the materials are listed in each activity, the total list is compiled below for the convenience of the teacher.

alcohol (1)
block of paraffin (1)
block of wood (1)
charcoal
clay (1)
cork (2) deep freeze unit (1)
dry ice (1)
eggs (6)
eight-inch flower pot (1)
flour (1 cup)
food coloring
heat-treated thermometer (1)
hot plate (1)
ice cubes (8)
knife or screw driver (1)
magnifying glass (6)
medicine bottle with top (1)
medicine dropper (5)
metal pan (2)
paper milk cartons (5)
piece of cloth (2)
piece of glass (2)
razor blades (6 double edge)
salt (1)
sand
7-Up (1)
small stones
spoon (2)
stand (1)
sugar (½ pound)
Thermos top or cap (1)
twigs
water glasses (15)
white vinegar (1 bottle)

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Recognizing Space-Time Relations•Controlling Variables•

PROCESSES•PROCESSES•PROCESSES•PROCESSES

Inferring•Formulating Hypotheses•Defining Operationally•

PROCESSES•PROCESSES•PROCESSES•PROCESSES

nterpreting Data•Recognizing Number Relations•Predictin

PROCESSES•PROCESSES•PROCESSES•PROCESSES

Recognizing Number Relations • Formulating Hypotheses •

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Observing • Classifying • Measuring • Communicating • Obse

SCIENCE CONTENT — PROCESS CHART

(Suggested methods for organizing science curriculum topics for K-Grade 6)

	CONTENT Life Science		Earth Science		Physical Science			Mathematical Science	
PROCESS	**Plants**	**Animals**	**Rocks & Minerals**	**Weather & Astronomy**	**Properties & Changes of Matter**	**Force & Motion**	**Magnetism & Electricity**	**Geometry**	**Graphing & Functions**
Observing	K,P	K,P		P	K,P	P	P,I	K,P	P
Measuring	K,P,I	P,I	K	P	K,P,I	P,I,M		P	M
Classifying	P	P	P,I		P,I			P	
Communicating	K,P,I	P,I	K,I	P	K,P		I	I	I,M
Predicting	I	M			I,M	I,M	I		I
Inferring	I	I			I		I,M		
Constructing Operational Definitions	M	I			I	I,M	I,M		M
Defining Variables	I,M	M			I	I			
Interpreting Data	M	M	I	M	I,M	M	I	I	M
Formulating Questions, Hypotheses, Models	M	M							
Experimenting	M	M			I	I	M		

K — Kindergarten
P — Primary (Grades 1-3)
I — Intermediate (Grades 4-5)
M — Upper elementary or first level middle school (Grade 6)

[redacted]

Bendick, Jeanne. *Measuring*. New York: Franklin Watts, 1971.

Berger, Melvin. *South Pole Station*. New York: John Day, 1971.

Blough, Glen O., and Julius Schwartz. *Elementary School Science and How to Teach It*. 5th ed. New York: Holt, Rinehart and Winston, 1974.

Bobrowsky, Kenneth et al. *You: A Body of Science; The Living Scene; The Air Above, The Ground Below; Power and Man*. New York: Scholastic, 1971.

Carin, Arthur, and Robert B. Sund. *Teaching Science Through Discovery*. 3rd ed. Columbus, Ohio: Charles E. Merrill Books, Inc., 1975.

Educators Progress Service. *Educators Guide to Free Science Material*. 16th Annual Edition. Compiled and edited by Mary Horkheimer Saterstrom. Randolph, Wisconsin: Educators Progress Service, 1975.

Fey, James T. *Long, Short, High, Low, Thin, Wide*. New York: Thomas Y. Crowell, 1971.

Fisher, S. H. *Table Top Science: Physics Experiments for Everyone*. Garden City, NY: Natural History Press, 1972. o.p.

Gega, Peter C. *Science in Elementary Education*. 2nd ed. New York: John Wiley and Son, Inc., 1970.

Goldreich, Gloria and Esther Goldreich. *What Can She Be? A Veterinarian*. New York: Lothrop, Lee & Shepard, 1972.

Habben, Dorothy. *Science Experiments That Really Work*. Chicago: Follet, 1970. o.p.

Harbeck, Richard. *Exploring Science in Your Home Laboratory*. School Book Service, 1972. o.p.

Hillcourt, William H. *Fun With Nature Hobbies*. New York: Putnam's, 1970.

Hone, Elizabeth B., Alexander Joseph, and Edward Victor. *Teaching Elementary Science: A Source Book for Elementary Science*. 2nd ed. New York: Harcourt Brace and World, Inc., 1971.

Lewis, June E., and Irene C. Potter. *The Teaching of Science in the Elementary School*. 2nd ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970.

The Life Nature Library. Individual authors for each volume and the editors of *Life*. New York: Time Incorporated. (Each volume has an individual copyright date.)

The Life Science Library. Each volume has an author and the editors of *Life*. New York: Time incorporated. (Each volume has an individual copyright date.)

McKern, Sharon S. *Exploring the Unknown: Mysteries in American Archaeology*. New York: Praeger, 1972. o.p.

Milgrom, Harry. *ABC Science Experiments*. New York: Crowell-Collier, 1970.

Milgrom, Harry. *Adventures with a Ball*. New York: E. P. Dutton and Company, Inc., 1967. o.p.

Navarra, J. G., and Joseph Zafforoni. *Science Today for the Elementary School Teacher*. Evanston, Illinois: Harper and Row, Inc., 1969

Nelson, Leslie W., and George C. Lorbeer. *Science Activities for Elementary Children*. 5th ed. Dubuque, Iowa: W.C. Brown Company, 1972.

Newman, James R., Editor. *The Harper Encyclopedia of Science*. Evanston, Illinois: Harper and Row, Inc., 1967. o.p.

Piltz, Albert, and Robert Sund. *Creative Teaching of Science in the Elementary School*. 2nd ed. Boston: Allyn & Bacon, 1974.

Podendorf, Illa. *Stepping into Science series: Animals and More Animals; Food Is for Eating; Many Is How Many?; Shapes: Sides, Curves and Corners; Sound All About; Things Are Alike and Different; Things Are Made to Move; Toby on the Move*. Chicago: Children's, 1970.

Stepping into Science series: Change and Time; Color; Predicting with Plants; Living Things Change; Tools for Observing. Chicago: Children's, 1971.

Rockcastle, V., Editor. *Cornell Science Leaflets*. Ithaca, New York: Cornell University.

Simak, Clifford D. *The March of Science*. New York: Harper & Row, 1971.

Simon, Seymour. *Science at Work: Easy Models You Can Make*. New York: Franklin Watts, 1971.

Stone, A. Harris. *Science Projects that Make Sense*. New York: McCall Books, 1971.

Stone, George K., and Lucy W. Stephenson. *Science You Can Use*. 2nd ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964.

Sund, Robert B., William Tillery, and Leslie Trowbridge. *Elementary Science Discovery Lessons, 3 vols*. Boston: Allyn and Bacon, 1970. o.p.

Tannenbaum, Beulah and Myra Stillman. *Understanding Sound*. New York: McGraw-Hill, 1971.

Victor, Edward. *Science for the Elementary School*. 3rd ed. New York: The Macmillan Company, 1974.

Victor, Edward, and Marjorie Lerner. *Readings in Science Education for Elementary Schools*. New York: Macmillan Company, 1967.

Wyler, Rose. *The First Book of Science Experiments*. New York: Franklin Watts, 1971.

Young People's Science Encyclopedia. Chicago: Children's, 1970.

Zim, Herbert S., and others. *Golden Nature Guides*. New York: Golden Press, (A set of about 36 titles with copyrights from 1948 to 1966.)

SCIENCE PERIODICAL PUBLICATIONS

Carolina Tips. Carolina Biological Supply Company, Burlington, NC 27215. Free publication on request.

The Instructor. Instructor Publications, Inc., Seven Bank Street, Danvill, NY 14437. Subscription.

Science, American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington, DC 20005. Subscription.

Science and Children. National Science Teachers Association, 1742 Connecticut Avenue N.W., Washington, DC 20006. Subscription.

The Science Teacher. National Science Teachers Association, 1742 Connecticut Avenue N.W., Washington, DC 20006. Subscription.

The Scientific American. Scientific American, Inc., 415 Madison Avenue, New York, NY 10017. Subscription.

Teacher. Macmillan Professional Magazines, Inc., 866 Third Avenue, New York, NY 10022. Subscription.

Turtox News. Macmillan Science Co., Inc., 8200 South Hoyne Avenue, Chicago, IL 60620. Free publication on request.

Ward's Bulletin. Ward's Natural Science Establishment, Inc., P.O. Box 1712, Rochester, NY 14603. Free Publication.

PUBLISHERS OF SCIENCE BOOKS

Abelard-Schuman, Ltd., 666 Fifth Avenue, New York, NY 10019.

Abingdon Press, 201 Eighth Avenue, South, Nashville, TN 37202.

Allyn and Bacon, Inc., 470 Atlantic Avenue, Boston, MA 02210.

American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington, DC 20005.

American Book Co., 450 West 33rd Street, New York, NY 10001.

American Forestry Association, 1319 18th Street, N.W., Washington, DC 20036.

American Library Association, 50 East Huron Street, Chicago, IL 60611.

American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024.

American Nature Association, 1214 Sixteenth Street, N.W., Washington, DC 20006.

Americana Corporation, 575 Lexington Avenue, New York, NY 10022.

Appleton-Century-Crofts, Inc., 292 Madison Avenue, New York, NY 10017.

Atheneum Publishers, 122 East 42nd Street, New York, NY 10017.

Basic Books, Inc., 10 East 53rd Street, New York, NY 10022.

Benefic Press, 10300 West Roosevelt Road, Westchester, IL 60153.

Robert Bentley, Inc., 872 Massachusetts Avenue, Cambridge, MA 02139.

Bobbs-Merrill Co., 4300 West 62nd Street, Indianapolis, IN 46206.

R. R. Bowker Co., 1180 Avenue of the Americas, New York, NY 10036.

Cambridge University Press, 32 East 57th Street, New York, NY 10022.

Children's Press, Inc., 1224 West Van Buren Street, Chicago, IL 60607.

F. E. Compton & Co., 425 North Michigan Avenue, Chicago, IL 60611.

Cornell University Press, 124 Roberts Place, Ithaca, NY 14850.

Coward-McCann and Geoghegan, Inc., 200 Madison Avenue, New York, NY 10016.

Creative Educational Society, Inc., 123 South Broad Street, Mankato, MN 56001.

Criterion Books, Inc., 666 Fifth Avenue, New York, NY 10019.

Thomas Y. Crowell Co., 10 East 53rd Street, New York, NY 10022.

P. F. — Collier, Inc., 866 Third Avenue, New York, NY 10022.

Crown Publishers, Inc., 419 Park Avenue, South, New York, NY 10016.

John Day Co., 666 Fifth Avenue, New York, NY 10019.

Devin-Adair Co., 143 Sound Beach Avenue, Old Greenwich, CT 06870.

Dial Press, Inc., One Dag Hammarskjold Plaza, New York, NY 10017.

Dodd, Mead & Co., 79 Madison Avenue, New York, NY 10016.

Doubleday & Co., Inc., 245 Park Avenue, New York, NY 10017.

E. P. Dutton & Co., 201 Park Avenue, South, New York, NY 10003.

Encyclopaedia Britannica Press, 425 Michigan Avenue, Chicago, IL 60611.

Field Enterprises Educational Corp., 510 Merchandise Mart Plaza, Chicago, IL 60654.

Follett Publishing Co., 1010 West Washington Blvd., Chicago, IL 60607.

W. H. Freeman and Co., 660 Market Street, San Francisco, CA 94104.

Garrard Publishing Co., 107 Cherry Street, New Canaan, CT 06840.

Ginn & Co., 191 Spring Street, Lexington, MA 02173.

Golden Press, Inc., 1220 Mound Avenue, Racine, WI 53404.

Grolier Inc., 575 Lexington Avenue, New York, NY 10022.

Grosset & Dunlap, Inc., 51 Madison Avenue, New York, NY 10010. (Mail orders to 227 East Center St., Kingsport, TN 37660).

C. S. Hammong & Co., 515 Valley Street, Maplewood, NJ 07040.

Harcourt Brace Jovanovich, Inc., 757 Third Avenue, New York, NY 10017.

Harvard University Press, 79 Garden Street, Cambridge, MA 02138.

Harper & Row, Publishers, 10 East 53rd Street, New York, NY 10022.

Hart Publishing Co., 15 West Fourth Street, New York, NY 10012.

Harvey House, Inc., c/o E. M. Hale Co., 20 Waterside Plaza, New York, NY 10010.

Hastings House, Publishers, Inc., 10 East 40th Street, New York, NY 10016.

Hawthorn Books, Inc., 260 Madison, New York, NY 10016.

D. C. Heath and Company, 125 Spring Street, Lexington, MA 02173.

Holiday House, 18 East 53rd Street, New York, NY 10022.

Holt, Rinehart and Winston, Inc., Publishers, 383 Madison Avenue, New York, NY 10017.

Horn Book, Inc., 585 Boylston Street, Boston, MA 02116.

Houghton Mifflin Co., 2 Park St. Boston, MA 02107.

Indiana University Press, 10th & Morton Streets, Bloomington, IN 47401.

International Publishers, 381 Park Avenue, South, New York, NY 10016.

Alfred A. Knopf, Inc., 201 East 50th Street, New York, NY 10022.

Lantern Press, Inc., 354 Hussey Road, Mt. Vernon, NY 10552.

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McGraw-Hill Book Co., Inc., 1221 Avenue of the Americas, New York, NY 10036.

David McKay Co., Inc., 750 Third Avenue, New York, NY 10017.

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The Meredith Publishing Co., 1716 Locust Street, Des Moines, IO 50336.

G. & C. Merriam Co., 47 Federal Street, Springfield, MA 01101.

Julian Messner, Inc., 1230 Avenue of the Americas, New York, NY 10020.

William Morrow and Co., Inc., 105 Madison Avenue, New York, NY 10016.

C. V. Mosby Company, 11830 Westline Industrial Drive, St. Louis, MO 63141

National Geographic Society, Department FBJ, 17th & "M" Streets, N.W., Washington, DC 20036.

National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, DC 2009.

Thomas Nelson & Sons, 30 East 42nd Street, New York, NY 10017.

The New American Library, Inc., 1301 Avenue of the Americas, New York, NY 10019.

New York Graphic Society, 34 Beacon Street, Boston, MA 02106.

Oxford University Press, 200 Madison Avenue, New York, NY 10016.

Pantheon Books, Inc., 201 East 50th Street, New York, NY 10022.

Frederick A. Praeger, Inc., 111 Fourth Avenue, New York, NY 10003.

Prentice-Hall, Inc., Route 9W, Englewood Cliffs, NJ 07632.

G. P. Putnam's Sons, 200 Madison Avenue, New York, NY 10016.

Rand McNally & Co., Box 7600 Chicago, IL 60680

Random House, Inc., 201 East 50th Street, New York, NY 10022.

Ronald Press Co., 79 Madison Avenue, New York, NY 10016.

Roy Publishers, 30 East 74th Street, New York, NY 10021.

St. Martin's Press, 175 Fifth Avenue, New York, NY 10010.

Scholastic Book Service, 50 West 44th Street, New York, NY 10036.

Scott, Foresman and Co., 1900 East Lake Avenue, Glenview, IL 60025.

Charles Scribner's Sons, 597 Fifth Avenue, New York, NY 10017.

Silver Burdett Co., 250 James Street, Morristown, NJ 07960.

Simon and Schuster, Inc., 1230 Avenue of the Americas, New York, NY 10020.

Spencer International Press, Inc., 575 Lexington Avenue, New York, NY 10022.

Steck Vaughn, Co., Box 2028, Austin, Texas 78767.

Sterling Publishing, Co., Inc., 419 Park Avenue, New York, NY 10016.

Superintendent of Documents, Government Printing Office, Washington, DC 20402.

Time-Life Books, A Division of Time, Inc., Time and Life Building, Rockefeller Center, New York, NY 10020.

University of Chicago Press, 5801 Ellis Avenue, Chicago, IL 60637.

University of Michigan Press, 615 East University, Ann Arbor, MI 48106.

University of Minnesota Press, 2307 University Avenue, S.E., Minneapolis, MN 55455

Vanguard Press, Inc., 424 Madison Avenue, New York, NY 10017.

Viking Press, 625 Madison Avenue, New York, NY 10022.

Frederick Warne & Co., Inc., 101 Fifth Avenue, New York, NY 10003.

Franklin Watts, Inc., 730 Fifth Avenue, New York, NY 10019.

Albert Whitman & Co., 560 West Lake Street, Chicago, IL 60606.

Whitman Publishing Co. (Western Publishing Co., Inc.), 1220 Mound Avenue, Racine, WI 53404.

H. W. Wilson Co., 950 University Avenue, New York, NY 10452.

The World Publishing Company, 2231 West 110th Street, Cleveland, OH 44102.

[redacted]

AMERICAN BIOLOGY TEACHER, "Audiovisual Reviews" Section. Published nine times a year. National Association of Biology Teachers, 11250 Roger Bacon Drive, Reston, VA 22090.

AV GUIDE, "The AV Shoppe" Section. Published monthly. AV Guide, 434 South Wabash, Chicago, IL 60605.

BOOKLIST, Published twice a month September through July and once in August. American Library Association, 50 East Huron Street, Chicago, IL 60611.

EDUCATOR'S GUIDE TO FREE SCIENCE MATERIALS, Revised periodically, Educator's Progress Service, Randolf, WI 53956.

FILM NEWS, Published five times a year. Film News Co., 250 West 57th Street, Suite 2202, New York, NY 10019.

GUIDE TO GOVERNMENT LOAN FILM (16mm), Revised periodically. 4th edition edited by Daniel Sprecher, Serina Press, 70 Kennedy Street, Alexandria, VA 22305.

INSTRUCTOR, "Reviews" Section. Published nine times a year. Instructor Publications, Inc., P. O. Box 6099, Duluth, MN 55806.

LANDERS FILM REVIEWS, Published five times a year. Landers Associates, Box 69760. Los Angeles, CA 90069.

MEDIA REVIEW DIGEST, Published quarterly with annual cumulation. Pierian Press, 5000 Washtenaw Avenue, Ann Arbor, MI 48104.

PREVIEWS, Published nine times a year. R. R. Bowker Co., 1180 Avenue of the Americas, New York, NY 10036.

SCIENCE ACTIVITIES, "Classroom Aids" Section; Published bimonthly. Heldref Publications, 4000 Albemarle Street, N.W., Washington, DC 20016.

SCIENCE AND CHILDREN, "Resources Reviews" Section. Published eight times a year. National Science Teachers Association, 1742 Connecticut Avenue N.W., Washington, DC 20009.

TEACHER, "Keeping Up." Section. Published nine times a year. MacMillan Professional Magazines, 77 Bedford Street, Stamford, CT 06901.

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Academy Films, 748 North Seward Street, Hollywood, CA 90038.

Almanac Films, Inc., 915 Broadway West, New York, NY.

American Airlines: Ask the office near you for information, 633 Third Avenue, New York, NY 10017.

American Cancer Society, Inc., 219 East 42nd Street, New York, NY 10017.

American Heart Association, Inc., Film Library, 44 East 23rd Street, New York, NY 10010. (Films also available from local Heart Association).

American Museum of Natural History, Slide Library, Central Park West at 79th Street, New York, NY 10024.

American Petroleum Institute, Committee on Public Affairs, 1271 Avenue of the Americas, New York, NY 10020.

American Red Cross (Contact nearest American Red Cross chapter.)

Association Films, Inc., 600 Madison Avenue, New York, NY 10022 (branch office in Dallas, Texas.)

Audio Film Center, 2138 East 7th Street, Mount Vernon, NY 10550.

Bailey Film Associates, 11559 Santa Monica Boulevard, Los Angeles, CA 90025.

Bell Telephone System (contact local Bell Telephone Co. offices for address of regional distributor; or contact the American Telephone and Telegraph Co., Motion Picture Section, 195 Broadway, New York, NY 10007.)

BTA Educational Media, 2211 Michigan Avenue, Santa Monica, CA 90404.

Better Vision Institute, Inc., 230 Park Avenue, New York, NY 10017.

Blackhawk Films, 1235 West Fifth Street, Davenport, Iowa 52805.

Robert J. Brady Co., Route 450 & 197, Bowie, MD 20715.

Brandon Films, Inc., 244 Kearney Street, San Francisco, CA 94108.

Carousel Films, Inc., 1501 Broadway, New York, NY 10036.

Cenco Educational Films, 2600 South Kostner, Chicago, IL 60623.

Churchill Films, 662 North Robertson Boulevard, Los Angeles, CA 90069.

Civil Aeronautics Administration, Aviation Education Division, 1825 Connecticut Avenue N. W., Washington, DC 20428.

Contemporary Films, Inc., 267 West 25th Street, New York, NY 10001.

Coronet Instructional Films, 65 East South Water Street, Chicago, IL 60601.

DeKalb Agricultural Association, Inc., Educational Dept. 111 East State Street, Sycamore, IL 60178.

Walt Disney Productions, Educational Film Division, 500 South Buena Vista Avenue, Burbank, CA 91503 (branch office in New York, NY.)

E. I. DuPont de Nemours & Co., Inc., Motion Picture Section, Advertising Dept. 1007 Market Street, Wilmington, Del. 19898.

Encyclopaedia Britannica Educational Corp., 425 N Michigan, Chicago, Il 60611 (branch offices in Hollywood, CA; Atlanta, GA; Skokie, IL; New York, NY; Dallas, TX; Toronto, Ontario, Canada).

Educational Testing Services, 20 Nassau Street, Princeton, NJ 98540 (branch office in Los Angeles, CA).

Eye Gate House, Inc., 146-01 Archer Avenue, Jamaica, NY 11435.

Films Incorporated, 1144 Wilmette Avenue, Wilmette, IL 60091.

Filmstrip House, 432 Park Avenue S., New York, NY 10016.

General Electric Co. Educational Films, Corporation Park, Bldg. 705, Scotia, NY 12302.

Handel Film Corp. 8730 Sunset Boulevard, West Hollywood, CA 90069.

Harper & Row, 10 East 23rd Street, New York, NY 10022.

Ideal Pictures, 321 West 44th Street, New York, NY 10036.

International Film Bureau, Inc., 332 South Michigan Avenue, Chicago, IL 60604 (branch office in Ottawa, Ontario, Canada.)

Indiana University, Audio-Visual Center, Bloomington, IN 47401.

Jam Handy School Services, Inc., 2781 East Grand Boulevard, Detroit, Michigan 48211.

Journal Films, 909 West Diversey Parkway, Chicago, IL 60614.

Life Filmstrips, Time and Life Bld., Nine Rockefeller Plaza, New York, NY 10020.

Long Filmslide Service, 7505 Fairmount Avenue, El Cerrito, CA 94530.

McGraw-Hill Book Company, Inc., Text-Film Dept., 1221 Avenue of the Americas, New York, NY 10020.

Metropolitan Life Insurance Company, Health and Welfare Division, One Madison Avenue, New York, NY 10010 (offices in San Francisco, CA, and Ottawa, Ontario, Canada.)

Michigan Dept. of Conservation, Film Loan Service, Lansing, MI 48926.

Michigan State University , Co-operative Extension Service, Agricultural Hall, Room 10, East Lansing, MI 48823.

Missouri Conservation Commission, Film Loan Library, Monroe Bldg., Jefferson City, MO 65101.

Modern Talking Picture Service, Inc., Headquarters Office, 1212 Avenue of the Americas, New York, NY 10031.

Moody Institute of Science, Educational Films Division, 12000 East Washington Blvd., Wittier, CA 90606.

NET Film Service, Audio-Visual Center, Indiana University, Bloomington, IN 47401.

National Educational Television & Radio Center, 10 Columbus Circle, New York, NY 10019.

National Film Board of Canada, 680 Fifth Avenue, Suite 819, New York, NY 10019.

The National Foundation, Public Information Dept. 800 Second Avenue, New York, NY 10017.

National Tuberculosis Association, 1790 Broadway, New York, NY 10019 (Films loaned through state and local tuberculosis associations.)

Ohio Dept. of Natural Resources, Division of Wild Life, 1500 Dublin Road, Columbus, OH 43212.

Oregon State System of Higher Education, Dept. of Audio Visual Services, General Extension Division, 133 Gill Coliseum, Corvallis, OR 97331.

Pennsylvania State University, Audio-Visual Aids Library, University Park, PA 16802.

Productions Unlimited, Inc., 1564 Broadway, New York, NY 10036.

Shell Oil Co., Public Relations Dept. 50 West 50th Street, New York, NY 10020.

Society for Visual Education, Inc., 1345 Diversey Parkway, Chicago, IL 60614.

State University of New York, College of Forestry at Syracuse University, Dept. of Forest Extension, Syracuse, NY 13210.

Sterling Educational Films, 241 East 34th Street, New York, NY 10016.

Sterling Movies U.S.A., 375 Park Avenue, New York, NY 10022.

Swank Motion Pictures, Inc., 201 South Jefferson, St. Louis, MO 63166.

Syracuse University, Film Library, Collandale Campus, 1455 East Colvin Street, Syracuse, NY 13210.

Teaching Film Custodians, Inc., 25 West 43rd Street, New York, NY 10036.

Technifax Corporation, 195 Appleton Street, Holyoke, MA 01040.

Thorne Films, Inc., 1229 University Avenue, Boulder, CO 80302.

U.S. Department of Agriculture, Motion Picture Service, Office of Information, Room 1850 South Bldg., Washington, DC 20250.

U.S. Department of Defense, The Pentagon, Washington, DC 20301.

U.S. Department of the Air Force, Directorate of Public Relations, Pictorial Branch, Washington, DC 20301.

U.S. Department of the Army, The Pentagon, Washington, DC 20301.

U.S. Department of the Navy, Office of Information, The Pentagon, Washington, DC 20350.

U.S. Forest Service, Dept. of Agriculture, 12th Street & Independence Avenue, S.W., Washington, DC 20250 (contact film library of your state university extension division or regional office of the U.S. Forest Service.)

U.S. Information Agency, 1750 Pennsylvania Avenue, N.W., Washington, DC 20547.

U.S. Office of Education, 400 Maryland Avenue, S.W., Washington, DC 20202.

U.S. Public Health Service, Welfare Bldg., Fourth Street and Independence Avenue, Washington, DC 20201.

U.S. Weather Service, 6010 Executive Blvd., Rockville, MD 20852.

United World Films, Inc., 221 Park Avenue South, New York, NY 10003 (branch offices in Los Angeles, CA; Miami, FL; Atlanta, GA; Chicago, IL; Portland, OR; Dallas, TX.)

University of California at Berkeley, Department of Visual Instruction, 22272 Union Street, Berkeley, CA 94720.

University of California at Los Angeles, University Extension, Educational Film Sales Dept., Los Angeles, CA 90024.

University of Michigan, Audio-Visual Education Center, 416 Fourth Street, Ann Arbor, MI 48103.

University of Minnesota, Audio-Visual Education Service, Westbrook Hall, Room 55, 2037 University Avenue S.E., Minneapolis, MN 55455.

University of Nebraska, Bureau of Audio-Visual Instruction, Extension Division, 421 Nebraska Hall, Lincoln, NE 68503.

University of Southern California, Department of Cinema, Filmstrip Distribution Division, University Park, Los Angeles, CA 90007.

University of Texas, Visual Instruction Bureau, Little Campus, Austin, Texas 78705.

University of Wisconsin, Bureau of Audio-Visual Instruction, University Extension, P.O. Box 2093, Madison, WI 53701.

Wexler Film Productions Inc., 801 North Seward Street, Los Angeles, CA 90038.

The regional education service centers of Texas are major sources of instructional resources. For example, *The Elementary Science Transparency Project* developed by the Texas Education Agency is available through the centers.

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American Electronic Laboratories, Inc., P.O. Box 552, Lansdale, PA 19446.

American Hospital Supply Corp. 1740 Ridge Avenue, Evanston, IL 60204.

American Optical Co., Sugar & Eggert Roads—14215, Buffalo, NY (optical instruments).

American Type Culture Collection, 12301 Parklawn Drive, Rockville, MD 20852 (bacteria).

Bausch & Lomb Optical Co., 635 St. Paul Street, Rochester, NY 1462 (optical instruments).

James G. Biddle Co., Township Line & Jolly Roads, Plymouth Meeting, PA 19462 (scientific instruments).

Burgess Inc., Exchange & Liberty Streets, Freeport, Il 61032 (dry cells).

Carolina Biological Supply Co., 2700 York Road, Burlington, NC 27215.

Central Scientific Co., 2600 South Kostner Avenue, Chicago, IL 60623.

Chemprene, Division of the Richardson Co., 570 Fishkill Avenue, Beacon, NY 12508 (rubber coated fabrics).

Corning Glass Works, Science Products Division, Corning, NY 14830 (glassware).

Creative Playthings, Inc., P.O. Box 1100, Princeton, NJ 08540.

Curtin-Matheson Scientific Co., P.O. Box 1546, Houston, TX 77001 (or) 1103 Slocum, Dallas, TX 75207.

Denoyer-Geppert Co., 5235 Ravenswood Avenue., Chicago, IL 60640 (models, charts, slides, microscopes).

Difco Laboratories, Inc., P.O. Box 1058A, Detroit, MI 48232 (reagents, culture media)

Dow Chemical Co., P.O. Box 1592, Midland, MI 48640 (chemicals).

Eastman Kodak Co., 343 State Street, Rochester, NY 14650 (photographic supplies and equipment).

Edmund Scientific Co., E. C. 300 Ed Score Bldg., Barrington, NJ 08007 (scientific instruments).

Fisher Scientific Co., 711 Forbes Avenue, Pittsburgh, PA 15219 (chemicals, laboratory appliances).

Graf-Apsco of Illinois Inc., P.O. Box 192, Woodstock, IL 60098 (microscopes).

Hubbard Scientific Co., P.O. Box 104, Northbrook, IL 60062 (models and earth science kits).

Ideal School Supply Co., 1100 La Verghe, Oak Lawn, IL 60453.

Kimble Products Division, Owens-Illinois, Inc., P.O. Box 1035, Toledo, OH 43666 (glassware).

La Pine Scientific Co., 6001 South Knox Avenue, Chicago, IL 60629 (supplies, instruments, and chemicals).

Lederle Laboratories, Division of American Cyanamid Co., Middletown Road, Pearl River, NY 10965 (chemicals).

E. Leitz, Inc., Link Drive, Rockleigh, NJ 07647 (optical instruments).

Matheson Scientific, Inc., 1850 Greenleaf Avenue, Elk Grove Village, IL 60007.

Merck & Co., Inc., P.O. Box 2000, Rahway, NJ 07065 (chemicals).

Monsanto Co., 800 North Lindbergh Blvd. St. Louis, MO 63166 (chemicals).

Nasco Science Materials, 147 Janesville Avenue, Fort Atkinson, WI 53538.

National Biological Supply Co., Inc., 230 West Superior Street, Chicago, IL.

National Instrument Co., Inc., 4119 Ford Leigh Road, Baltimore, MD 21215.

National Teaching Aids, Inc., 120 Fulton Avenue, Garden City Park, NY 11044.

Nutritional Biochemicals Corp. 26208 Miles Avenue, Cleveland, OH 44128 (chemicals).

Nystrom Division Carnation Co., 3333 Elston Avenue, Chicago, IL 60618 (charts, models).

Practical Aids Company, Estacada, OR 97023.

Sargent-Welch Scientific Co., 7300 North Lindner Ave., Department 1C, Skokie, IL 60076.

Spitz Space Systems, Inc., Route 1, Chaddo Ford, PA 19317 (shadowboxes, plasteria).

Sprague-Dawley, Inc., P.O. Box 2071, Madison, WI 53701 (laboratory rats).

Stansi Education Materials, Division (Fisher Scientific Co.,) 1259 N. Wood Street, Chicago, IL 60622.

Turtox-Cambosco, MacMillan Science Co., Inc., 8200 S. Hoyne Avenue, Chicago, IL 60620.

Ward's of California, 316 Cannery Row, Monterey, CA 93942.

Wards Natural Science Establishment, Inc., P.O. Box 1712, Rochester, NY 14603.

Welch Scientific Co., 7300 N. Linder Avenue, Skokie, IL 60076.

You may also wish to consult the annual September issue of *Science* (American Association for the Advancement of Science) which is the "Guide to Scientific Instruments."

CURRICULUM DEVELOPMENT PROJECTS

Conceptually Oriented Program for Elementary Science
New York University, COPES Project, Four Washington Place, Room 502, New York, NY 10003.

Elementary Science Study
Education Development Center, 108 Water St., Watertown, Mass. 02172.

Elementary-School Science Project (in astronomy)
University of Illinois, 805 West Pennsylvania Avenue, Urbana, IL 61801.

The Elementary Science Transparency Project
Texas Education Agency, 201 East 11th Street, Austin, Texas 78701.

Intermediate Science Curriculum Study
For information, contact Adrian Lovell, Administrative Associate, 415 North Monroe Street, Room 410, Tallahassee, FL 32301. Inquiries regarding texts and equipment should be sent to: ISCS Product Manager, Silver Burdett, Morristown, NJ 07960.

Minnesota Mathematics and Science Teaching Project
MINNEMAST Project Director, 720 Washington, Ave., S.E., Minneapolis, Minn. 55414.

Science—A Process Approach
AAAS Commission on Science Education, 515 Massachusetts Ave., N.W., Washington, DC 20005.

Science Curriculum Improvement Study
Project Headquarters, Lawrence Hall of Science, University of California, Berkeley, CA 94720.

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, Department of Health, Education and Welfare.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964; EXECUTIVE ORDERS 11246 AND 11375; TITLE IX, 1973 EDUCATION AMENDMENTS; REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; AND VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulations by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs or activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.

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